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Environmental - Regulatory Review

Grand Calumet River and Indiana Harbor Canal

Great Lakes National Program Office
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Table of Contents

	Page
List of Exhibits	i
Introduction	1
Background	1
Water Quality	5
Sediment Quality	9
Fish Monitoring	21
Problem Areas	24
Location of Dischargers	25
Potential Problem Sources	26
Status of Facilities Plans & Construction Grants	30
Status of Enforcement Actions	32
Conclusions	34
References	38
Appendix A	39
Appendix B	40
Appendix C	45

List of Tables

		Page
(1)	Point Source Dischargers within the Grand Calumet River and Indiana Harbor Canal	6
(2)	Grand Calumet River Water Quality	10
(3)	Indiana Harbor Canal Water Quality	11
(4)	Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments	13
(5)	Indiana Harbor Canal Sediments	14
(6)	Grand Calumet River Sediments	15
(7)	Indiana Harbor Canal Sediments - Polynuclear Aromatic Hydrocarbons	19
(8)	Grand Calumet River Sediments - Polynuclear Aromatic Hydrocarbons	20
(9)	Macro-Invertebrates	22
(10)	Chemical Analysis of Grand Calumet River - Indiana Harbor Canal Fish	23
(11)	Landfills and Dumps	29
(12)	Surface Impoundment Assessment Study	31
(13)	Status of Enforcement Actions - Northwest Indiana	33

List of Figures

(1)	Location Map	3
(2)	Stream Flow patterns of the Grant and Little Calumet Rivers	4

I Introduction

The State of Indiana and the United States Environmental Protection Agency (USEPA) both agree that additional concerted state-federal effort is needed to improve Grand Calumet River-Indiana Harbor Canal (GCR-IHC) water quality to the point where multiple uses could be sustained. Toward that goal, the State-USEPA Agreement has highlighted northwest Indiana as the area where extensive state pollution control resources should be concentrated. As a preliminary step, the subject review was prepared to better define the remaining ecological problems within the GCR-IHC system. Because of the complexity of this system - both hydraulic and pollutional - this assessment deals with the GCR-IHC alone. It does not consider GCR-IHC effects upon southern Lake Michigan, to which the GCR-IHC discharges.

II Background

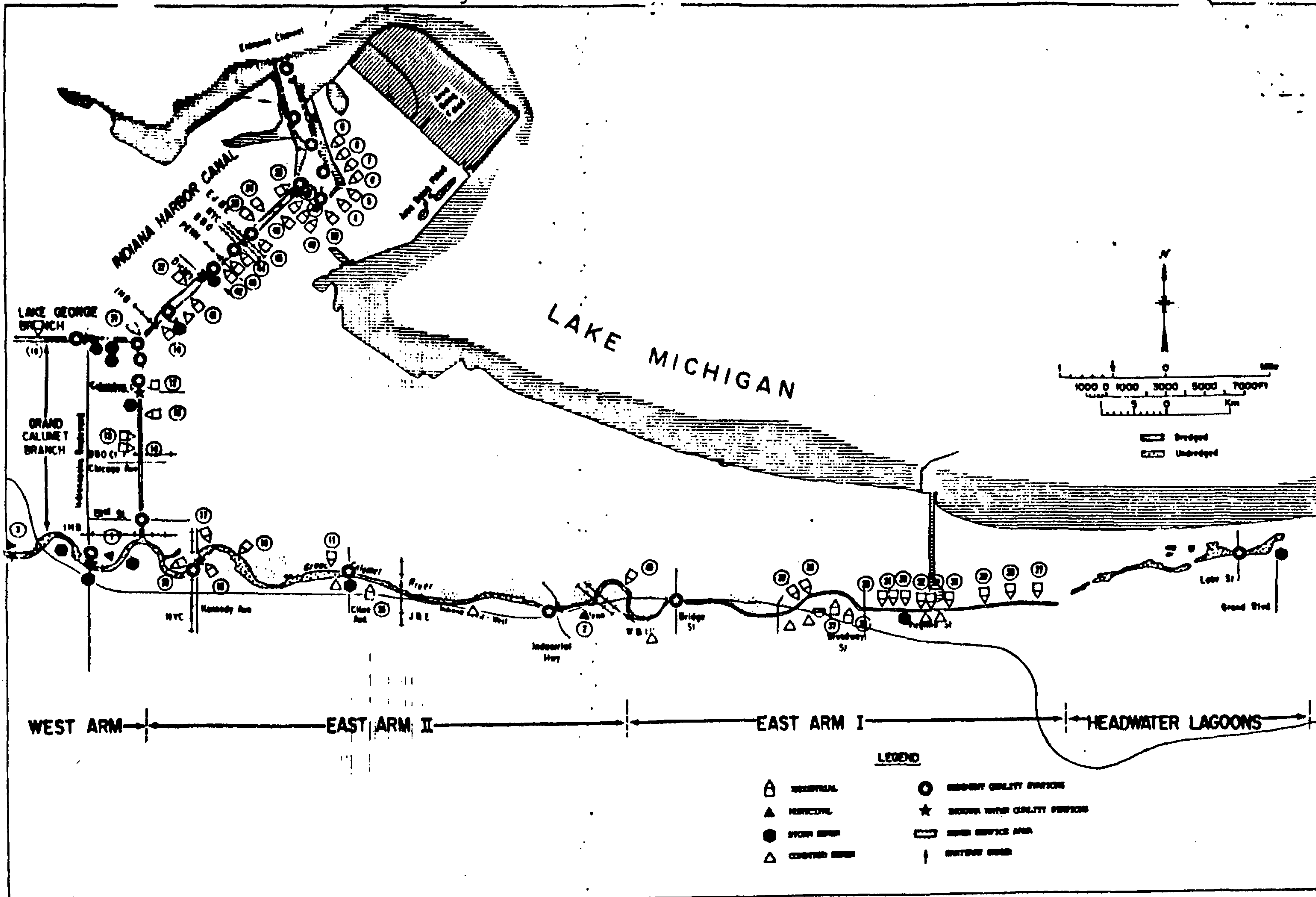
The Grand Calumet River Basin is located in the northwest corner of Indiana and the adjacent area of Illinois. The basin is contained almost wholly within Lake County encompassing approximately 43,242 acres. The Little Calumet River borders to the south while Lake Michigan lies to the north.

The Grand Calumet River (GCR) originates near a series of lagoons west of Marquette Park (Fig. 1). At one time these lagoons were the rivermouth, but diversion of river waters at the Cal-Sag Canal and Indiana Harbor Canal (IHC) has greatly reduced the flow. Eventually the mouth of the river was closed by drifing sand and aquatic vegetation. Presently the GCR is 13 river miles long (westward flow), being joined by the IHC three miles east of the Illinois border. Waters entering the IHC flow about five miles to the north and then northeast, exiting into southern Lake Michigan.

The topography of the Basin is flat and the river is shallow with the bottom covered with a mixture of organic debris, mud, and sludge. Due to man-made alterations to the stream channel, the flow pattern of the Grand Calumet River and the Indiana Harbor Canal (a man-made channel which connects the GCR to Lake Michigan) is quite complex. The east branch of the GCR flows westward to the IHC which flows northward to the Lake. The west branch of the GCR, however, is divided into two segments which are normally separated by a natural divide located near the east edge of the Hammond municipal wastewater treatment plant. Water in the east segment of the west branch joins the east branch of the river to form the IHC. Water in the west segment of the west branch on the other hand, occasionally flows westward into Illinois the result of weather conditions on Lake Michigan.

The IHC normally flows to Lake Michigan because of the great rate at which lake water is pumped into the canal via the Grand Calumet River by the U.S. Steel-Gary Works. However, the canal's flow may reverse itself for short periods of time, according to the stage of Lake Michigan. Figure 2 illustrates the stream flow patterns of the Grand and Little Calumet Rivers. Since no U.S.G.S. gaging stations are located within the Grand Calumet Basin, no information is available regarding the maximum and minimum flows of the GCR.

Figure 1: Location Map



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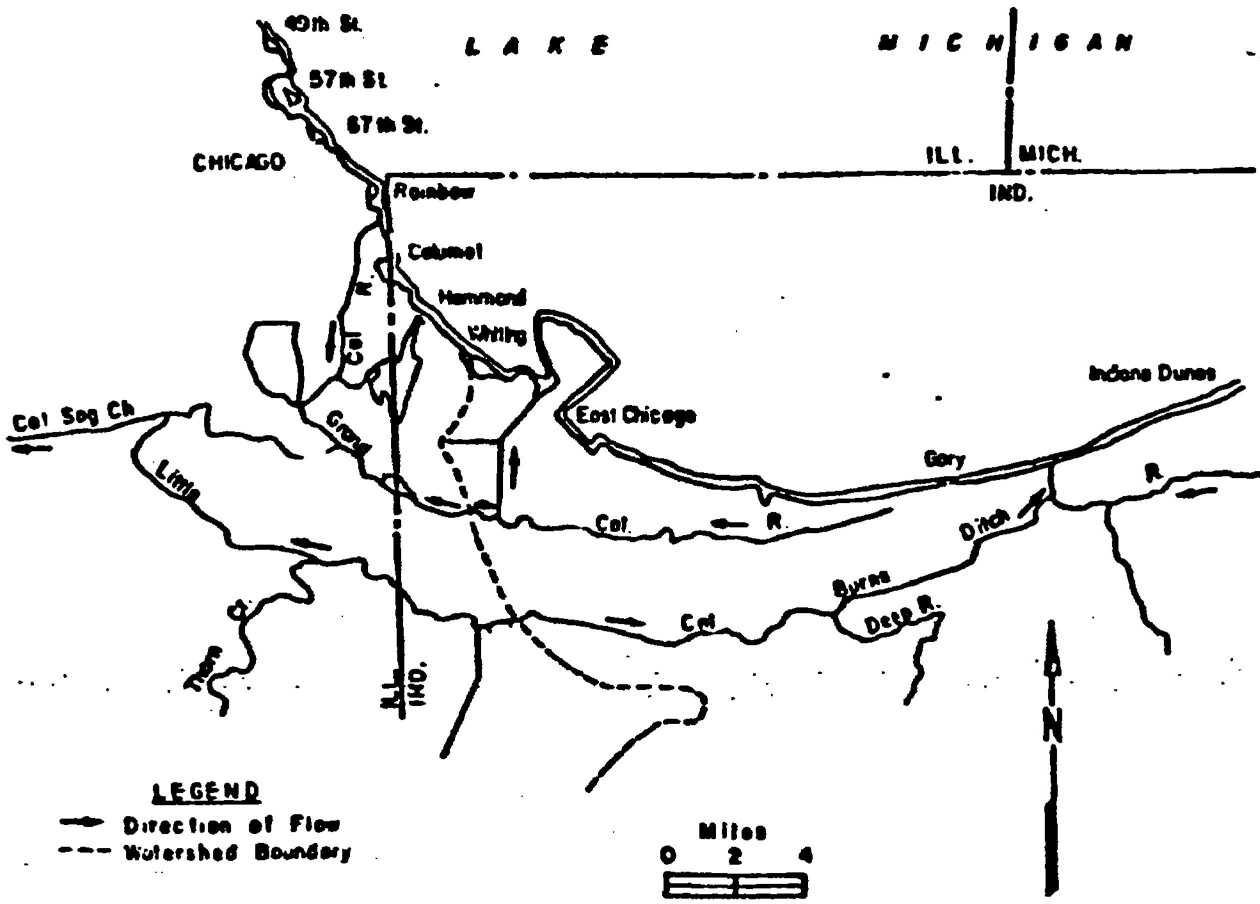


STREAM FLOW PATTERNS OF THE
GRAND AND LITTLE CALUMET RIVERS

07

Fig. 2

The backwater or estuary effect on the GCR-IHC caused by the varying Lake Michigan water levels makes a river stage-discharge relationship - the relationship measured at a gaging station - impossible to define. An additional gage to compensate for the backwater effect would produce results that could be as much as 50 percent in error. However, the expense of the multiple gages and the expected unreliability of the data, precludes establishment of a dual system in this area (7). Recent average flows have been estimated (1) and are discussed Page 9.

The major concentrations of population in the Basin are located in and around the cities of East Chicago, Gary, Hammond, and Whiting. Domestic and industrial wastewaters generated from these cities are discharged to the Grand Calumet River. Currently, three (3) municipal and 74 industrial point sources discharge to the Grand Calumet Basin (see Table 1). The Hammond and Gary Sanitary District wastewater treatment plants are regional facilities which serve some towns and industries located outside the Grand Calumet River Basin.

The GCR-IHC area has a population of over 500,000 and has one of the most concentrated steel and oil complexes in the nation. In excess of 90 percent of the water flowing in the GCR-IHC system enters as treated wastewater, industrial cooling/process water, and as storm water.

III Water Quality

Of all Indiana streams, the Grand Calumet River and the Indiana Harbor Canal violate all of the State Water Quality Standards (WQS) most frequently. The GCR-IHC water quality standards, which protect for partial body contact, limited aquatic life and industrial water supply are shown as Appendix B. While the water quality

Table 1

POINT SOURCE DISCHARGERS WITHIN THE GRAND CALUMET RIVER AND INDIANA HARBOR CANAL

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
Municipal Dischargers				
1.	East Chicago	0022829	Grand Calumet River	WWTP Effluent
2.	Gary	0022977	Grand Calumet River	WWTP Effluent
3.	Hammond	0023060	Grand Calumet River	WWTP Effluent
Industrial Dischargers				
4.	Inland Steel Co.	IN 0000094 -013	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
5.	Inland Steel Co.	-014	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
6.	Inland Steel Co.	-015	Indiana Harbor Turning Basin	Process Water WWTP Effluent Cooling Water
7.	Inland Steel Co.	-016	Indiana Harbor Turning Basin	Process Water WWTP Effluent Cooling Water
8.	Inland Steel Co.	-017	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
9.	Inland Steel Co	-018	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
10.	Union Carbide (E. Chicago)	IN 0000043	Indiana Harbor Canal/ Lake Michigan	Cooling Water
11.	Cities Service Oil Co. (E. Chicago)	IN 0000159	Grand Calumet River	Cooling Process
12.	Phillips Pipeline Co. (E. Chicago)	IN 0032999	Indiana Harbor Canal/ Lake Michigan	Cooling Process
13.	Blaw-Knox Foundry & Mill Machinery, Inc (E. Chicago)	IN 032549 -001	Indiana Harbor Canal/ Lake Michigan	Quench Water
14.	Blaw-Knox Foundry	-002 -003	Indiana Harbor Canal/ Lake Michigan	Storm Water Ground Water Cooling Water
15.	Harbison-Walker Refractories Co. (Hammond)	IN 0000248	Grand Calumet River	Cooling Water

Table 1
(Cont.)

POINT SOURCE DISCHARGES WITHIN THE GRAND CALUMET RIVER
AND INDIANA HARBOR CANAL (Cont.)

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
16.	E. I. duPont deNemours & Co. (E. Chicago)	IN 0000329 -001	Grand Calumet River	Cooling Water
17.	E.I. duPont deNemours	-002 -003	Grand Calumet River	Process Water Process Water
18.	C. F. Petroleum (E. Chicago) (Energy Cooperative, Inc.)	IN 0000051	West Branch/Indiana Harbor Canal/ Lake Michigan	Cooling, Process, Ballast & Storm Water
19.	America Steel Foundries	IN 0000167	Indiana Harbor Canal/ Lake Michigan	Process Water Cooling Water
20.	U.S. Lead Refiner (E. Chicago)	IN 0032425	Grand Calumet River	Process Water Cooling Water
21.	Jones and Laughlin Co. (E. Chicago)	IN 0000205 -001	Indiana Harbor Canal/ Lake Michigan	Process Water WWTP Effluent
22.	Jones and Laughlin Co.	-002	Indiana Harbor Canal/ Lake Michigan	Cooling (Cold rolling)
23.	Jones and Laughlin Co.	-009	Indiana Harbor Canal/	Cooling Water Power House
24.	Jones and Laughlin Co.	-010	Indiana Harbor Canal/	Cooling -
25.	Jones and Laughlin Co.	-011	Indiana Harbor Canal/ Lake Michigan	Process Water Cooling Water Mills & Hearths
26.	Petroleum Coke Calciner Kaiser Alum. & Chem. Corp. (Gary)	IN 0000141	Grand Calumet River	Cooling Water
27.	U.S. Steel Corp. Gary Works (Gary)	IN 0000281 -002 (GW-1) -005 (GW-1A)	Grand Calumet River	Process Water Cooling Water
28.	U.S. Steel Corp.	-007(GW-2)	Grand Calumet River	Cooling Water
29.	U. S. Steel Corp.	-010(GW-3)	Grand Calumet River	Cooling Water
30.	U.S. Steel Corp.	015(GW-4)	Grand Calumet River	Cooling Water

Table 1
(Cont.)

POINT SOURCE DISCHARGERS WITHIN THE GRAND CALUMET RIVER
AND INDIANA HARBOR CANAL (Cont.)

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
31.	U.S. Steel Corp.	-017(GW-5)	Grand Calumet River	Process Water Cooling Water
32.	U.S. Steel Corp.	-018(GW-6)	Grand Calumet River	Cooling Water
33.	U.S. Steel Corp.	-019(GW-7)	Grand Calumet River	Cooling Water
34.	U.S. Steel Corp.	-020(GW-7A)	Grand Calumet River	Process Water Cooling Water
35.	U.S. Steel Corp.	-021(GW-9)	Grand Calumet River	Cooling Water
36.	U.S. Steel Corp.	IN 0000281 -028(GW-10A)	Grand Calumet River	Process Water Cooling Water
37.	U.S. Steel Corp.	-030(GW-11A)	Grand Calumet River	Process Water Cooling Water
38.	U.S. Steel Corp.	-032(GW-13)	Grand Calumet River	Cooling Water
39.	U.S. Steel Corp.	-033(ST-14)	Grand Calumet River	Cooling Water
40.	U.S. Steel Corp.	-034(ST-17)	Grand Calumet River	Process Water Cooling Water
41.	Inland Steel Co. (E. Chicago)	IN 0000095 -001	Indiana Harbor Canal	Process Water Cooling Water Storm Water
42.	Inland Steel Co.	-002	Indiana Harbor Canal	Process Water Cooling Water Storm Water
43.	Inland Steel Co.	-003	Indiana Harbor Canal	Process Water Cooling Water
44.	Inland Steel Co.	-005	Indiana Harbor Canal	Process Water Cooling Water Storm Water
45.	Inland Steel Co.	-007	Indiana Harbor Canal	Cooling Water Storm Water
46.	Inland Steel Co.	-008	Indiana Harbor Canal	Cooling Water Storm Water
47.	Inland Steel Co.	-009	Indiana Harbor Canal	Unused Cooling
48.	Inland Steel Co.	-010	Indiana Harbor Canal	Unused Cooling
49.	Inland Steel Co.	-011	Indiana Harbor/ Turning Basin	Cooling Water Storm Water
50.	Inland Steel Co.	-012	Indian Harbor Turning Basin	WWTP Effluent Cooling Water Storm Water

standards have consistently been violated over the years, a review of the annual data shows some improvement of water quality in recent years (see Tables 2 and 3). The water quality standards being violated include dissolved oxygen, fecal coliform, bacteria, total dissolved solids, chlorides, sulfates, phosphorus, oil and grease, ammonia nitrogen, cyanide, phenols and mercury. The Indiana water quality standard for toxic substances is defined as not to exceed one-tenth of the 96 hour median tolerance limit for important indigenous species. Aquatic life historically indigenous to the GCR-IHC has been absent for years because the toxicant concentrations in the system have been, and are such, to preclude it's sustenance. Examination of data on Tables 2 & 3, obtained from Indiana Board of Health Annual Water Quality Reports, reveals that of the entire system, the west arm of the Grand Calumet River is by far the most polluted. While total pollutional inputs to both the west and the east arms may be comparable, the dilution capacity afforded by the industrial cooling water discharged to the east arm results in ambient water quality in the east arm that is less polluted than water quality in the west arm. As determined for the Northwest Indiana Regional Planning Commission 208 areawide waste treatment management planning program (1), the flow at the State of Indiana fixed monitoring station GCR-36 (Indianapolis Boulevard) in the west arm averages approximately 16 CFS, that of GCR-41 (Industrial Highway) in the east arm averages 880 CFS. While 80-90 percent of the flow entering the main stem of the Indiana Harbor Canal emanates from the Grand Calumet branch, the water quality in both feeder streams (Lake George branch and Grand Calumet branch) is comparable.

IV Sediment Quality.

The Grand Calumet River and the Indiana Harbor Ship Canal have large quantities of benthal deposits - as much as 12 feet in some locations. The predominant benthal deposits exist in the west branch of the Grand Calumet River and in the Harbor Canal north of Columbus Avenue.

Table 2

Grand Calumet River Water Quality
(mg/l unless noted otherwise)

Station	Hohman Ave.			Kennedy Ave.			Industrial Hy.		
Year	78	79	80	78	79	80	78	79	80
NH_3 mg/l									
Max.	12.0	15.0	15.0	4.5	4.6		6.6	6.0	3.2
Min.	0.5	3.5	3.4	2.2	1.1		2.2	1.3	0.7
Avg.	4.0	7.7	8.4	3.0	2.9		3.3	2.4	1.6
BOD mg/l									
Max.	120.0	200.0	150.0	8.5	7.2		86.0	47.0	10.0
Min.	2.5	6.5	7.3	2.0	3.0		3.0	3.3	1.0
Avg.	26.3	74.0	30.4	5.3	5.2		15.1	8.3	4.2
COD mg/l									
Max.	420	[illegible]	[illegible]	36	30		300	30	22
Min.	31	64	32	13	16		24	10	13
Avg.	127	236	132	25	[illegible]		61	22	16
Fecal Coliform per 100 ml									
Max.	110000	2700000	310000	63000	100000		640000	1800000	72000
Min.	10	18	5700	380	25000		670	2300	[illegible]
Avg.	33320	607092	81220	25133	60833		119615	304427	28250
D.O. mg/l									
Max.	8.9	6.6	6.9	9.2	9.5		9.8	10.6	11.0
Min.	1.0	0.1	1.1	2.4	2.3		4.9	5.1	5.5
Avg.	3.6	1.9	3.2	6.1	5.5		7.0	7.3	8.2
O+G mg/l									
Max.	32.0	24.0	32.3	6.0	11.0		5.0	9.3	31.0
Min.	1.0	2.0	1.0	1.0	1.0		2.0	1.0	1.0
Avg.	7.5	15.1	12.3	2.7	4.1		3.7	4.1	6.3
Phosphorus									
Max.	[illegible]	7900	[illegible]	270	250		330	[illegible]	130
Min.	600	800	500	120	110		150	40	30
Avg.	[illegible]	3300	[illegible]	170	160		230	140	60
S.S. mg/l									
Max.	280	460	460	22	28		32	25	24
Min.	4	22	10	12	8		11	7	6
Avg.	76	166	106	16	14		18	14	14
Cl									
Max.	140	248	180	45	43		42	36	40
Min.	79	70	80	25	26		25	23	22
Avg.	110	117	120	36	35		32	30	31
Cd									
Max.	10	10	10	-	-	-	-	-	-
Min.	10	10	2	-	-	-	-	-	-
Avg.	10	10	2.8	-	-	-	-	-	-
Cr									
Max.	80	100	30	40	50	-	80	80	30
Min.	10	30	1	10	10		10	10	10
Avg.	20	60	16	20	20		20	40	11
Cu									
Max.	120	510	100	-	-	-	-	-	-
Min.	20	20	6	-	-	-	-	-	-
Avg.	35	96	20	-	-	-	-	-	-
CN									
Max.	10	36	40	700	700	-	1200	670	16
Min.	1	1	5	100	25	-	80	20	5
Avg.	5	7	17	204	200	-	186	190	7
Total Fe									
Max.	3.7	27.0	5.4	1.3	1.4	-	1.3	1.5	1.2
Min.	0.4	0.9	0.76	0.6	0.7	-	0.7	0.7	0.4
Avg.	1.6	5.3	1.36	1.1	1.0		1.1	0.9	0.7
Hg									
Max.	0.8	2.0	2.2	0.9	3.3	-	0.9	0.1	0.2
Min.	0.1	0.1	0.4	0.1	0.1	-	0.1	0.1	0.1
Avg.	0.34	0.77	1.2	0.24	0.4	-	0.38	0.1	0.1
Phenol									
Max.	2400	270	105	-	-	-	-	-	-
Min.	7	5	5	-	-	-	-	-	-
Avg.	186	60	16	-	-	-	-	-	-
Pb									
Max.	300	600	140	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]
Min.	20	30	20	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	102	26	27	[illegible]	-	27	[illegible]	[illegible]
NO_3 mg/l									
Max.	6.7	10.0	2.4	2.2	1.0	-	0.5	0.8	0.6
Min.	0.3	0.1	0.1	0.2	0.4	-	0.3	0.4	0.3
Avg.	1.3	1.3	0.6	0.5	0.5	-	0.4	0.5	0.5

Table 3

Indiana Harbor Canal Water Quality
(mg/l unless otherwise noted)

Station	[illegible] Canal Mouth			Dickey Road			Columbus Dr.			Indianapolis Blvd.		
Year	78	79	80	78	79	80	78	79	80	78	79	80
DO (mg/l)												
Max.	7.5	6.5	7.9	7.7	8.1	9.1	8.7	8.8	9.8	4.0	8.2	8.3
Min.	3.5	4.3	1.4	0.4	0.6	1.0	1.1	1.2	2.7	0.6	0.4	1.1
Avg.	5.3	5.3	6.2	2.5	2.8	4.6	4.2	4.3	5.6	2.4	2.5	4.7
BOD (mg/l)												
Max.	47	31	30	29	31	25	32	31	40	37	42	54
Min.	10	7	6	17	16	15	18	14	11	18	18	6
Avg.	21	14	12	23	21	19	24	22	22	25	23	24
Fe (mg/l)												
Max.	-	- -	- -	-	-	-	0.7	1.5	1.1	1.5	3.3	1.2
Min.	-	-	- -	-	-	-	0.6	0.7	0.9	0.5	0.5	0.2
Avg.	-	-	- -	-	-	-	1.4	0.9	0.7	0.9	1.0	0.8
Cd												
Max.	10	20	2	-	-	40	-	-	-	-	-	-
Min.	10	10	2	-	-	40	-	-	-	-	-	-
Avg.	10	11	2	-	-	40	-	-	-	-	-	-
Cr												
Max.	10	20	40	100	100	70	60	60	110	80	50	30
Min.	10	10	10	10	10	10	10	10	10	10	10	10
Avg.	10	10	16	20	20	16	20	20	20	20	20	12
Cu												
Max.	30	30	6	-	-	-	-	-	-	-	-	-
Min.	30	20	6	-	-	-	-	-	-	-	-	-
Avg.	30	20	6	-	-	-	-	-	-	-	-	-
Zn												
Max.	35	400	24	560	90	25	490	440	57	300	520	16
Min.	1	5	5	30	5	5	55	60	5	4	5	5
Avg.	16	96	10	180	20	12	341	169	15	83	75	8
NH_3-N (mg/l)												
Max.	1.10	1.60	2.90	5.10	4.50	3.20	4.60	5.70	4.00	6.80	5.60	3.10
Min.	.50	.80	0.10	2.90	2.70	2.20	2.60	1.00	1.50	2.30	2.00	1.20
Avg.	.77	1.11	1.22	3.97	3.71	2.62	3.49	3.71	2.51	3.86	3.81	2.11
Chlorides (mg/l)												
Max.	29	30	63	67	66	64	61	76	56	90	87	100
Min.	21	21	17	46	42	36	34	27	28	40	40	44
Avg.	25	20	34	56	53	53	46	40	46	63	65	67
S.C.												
Max.	390	530	600	630	720	650	600	600	640	780	910	870
Min.	340	360	360	520	480	390	450	400	340	64	500	300
Avg.	370	436	423	565	605	543	583	563	500	549	652	610
Phosphorus												
Max.	80	750	160	300	300	180	310	760	530	300	240	180
Min.	40	30	30	160	120	40	140	120	60	110	130	30
Avg.	50	70	70	200	160	120	220	240	170	180	160	100
S.S. (mg/l)												
Max.	13	19	25	30	16	45	32	23	100	30	32	35
Min.	2	4	3	5	4	3	8	4	1	5	4	1
Avg.	8	9	10	13	9	14	25	14	20	11	10	11
Fecals												
Max.	7400	8500	40000	52300	85000	37000	210000	210000	64000	23000	40000	11000
Min.	60	250	140	1200	3600	2700	530	3300	2200	30	30	230
Avg.	2012	3000	8075	25716	37540	16180	54128	64608	27910	9452	12035	2340
[illegible] (mg/l)												
Max.	14.0	3.5	4.8	6.8	6.0	6.0	11.0	8.8	13.0	8.2	10.0	6.5
Min.	2.3	1.2	1.2	2.3	3.1	1.0	2.7	2.5	1.7	2.2	2.2	2.3
Avg.	4.7	2.0	2.4	4.6	3.9	3.4	6.0	4.8	6.8	4.1	3.8	3.3
Pb												
Max.	30	60	30	90	30	40	100	30	100	80	30	30
Min.	30	20	30	20	20	30	30	20	20	30	20	20
Avg.	30	34	30	34	30	22	34	30	27	26	23	22
Hg												
Max.	0.7	0.6	0.8	0.7	0.2	0.2	0.8	0.2	0.2	-	-	-
Min.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-
Avg.	0.3	0.17	0.17	0.26	0.12	0.11	0.3	0.11	0.12	-	-	-
O & G (mg/l)												
Max.	2.6	15.0	12.0	5.6	9.3	15.8	13.0	13.1	8.3	278.	13.0	24.0
Min.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.6
Avg.	1.6	2.0	5.0	2.0	2.0	3.5	3.4	4.0	2.8	34.1	3.9	3.0
SO_4 (mg/l)												
Max.	43	80	61	70	86	67	64	73	66	80	92	90
Min.	30	31	30	40	57	44	30	30	42	45	56	22
Avg.	37	42	42	50	66	50	52	50	52	64	71	71
Phenols												
Max.	-	-	30	85	70	97	80	80	14	30	35	7
Min	-	-	23	5	5	5	6	5	5	5	5	5
Avg.	-	-	25	19	13	16	30	21	9	12	8	6

The sediments have high concentrations of toxic constituents including polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), mercury, lead, zinc, arsenic, chromium, cadmium, and other metals. In addition, the sediments include high concentrations of oil and grease, phosphorus, nitrogen, iron, manganese, magnesium, volatile solids, and chemical oxygen demand. Based upon USEPA Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments (see Table 4) (12), and using data obtained from a November 1979 Corps of Engineers (COE) sediment study of the dredged portion of the Indiana Harbor Canal, and a December 1980 USEPA sediment study of the remaining undredged portion of the canal and the Grand Calumet River (see Tables 5,6), the sediments of the entire system can be classified as heavily polluted.

Both USEPA and COE took sediment cores at each sampling site. The cores were divided into strata and a chemical analysis was performed on each stratum. Tables 5 and 6 characterize and summarize the sediment core data as maximums, minimum, and averages for each site.

Because of bioaccumulation, the sediment guidelines consider PCB concentrations greater than 10 mg/kg (dry weight) as being polluted and not acceptable for open lake disposal. While some areas in the Grant Calumet River exceed all of the guidelines, other areas in the river do not. The greatest PCB sediment pollution occurs in the canal upstream of Columbus Avenue and extending lakeward to about the New York Central Railroad crossing. The highest sediment PCB concentration recorded was 89.2 mg/kg in the bottom half of the core taken at the NYCRR sampling site. The Lake George Branch sediments are fairly low in PCBs, it is indicated, therefore, that the high concentrations found in the Canal mainstem emanate from discharges to the mainstem and from the Grand Calumet Branch. There is much variability in the sediment core PCB concentrations.

Table 4

USEPA - Region V

GUIDELINES FOR THE POLLUTIONAL CLASSIFICATION

OF GREAT LAKES HARBOR SEDIMENTS

	NONPOLLUTED	MODERATELY POLLUTED	HEAVILY POLLUTED
Volatile Solids (%)	<5	5 - 8	>8
COD (mg/kg dry weight)	<40,000	40,000-80,000	>80,000
TKN " " "	<1,000	1,000-2,000	>2,000
Oil and Grease (Hexane Solubles) (mg/kg dry weight)	<1,000	1,000-2,000	>2,000
Lead (mg/kg dry weight)	<40	40-60	>60
Zinc " " "	<90	90-200	>200
Ammonia (mg/kg dry weight)	<75	75-200	>200
Cyanide " " "	<0.10	0.10-0.25	>0.25
Phosphorus " " "	<420	420-650	>650
Iron " " "	<17,000	17,000-25,000	>25,000
Nickel " " "	<20	20-50	>50
Manganese " " "	<300	300-500	>500
Arsenic " " "	<3	3-8	>8
Cadmium " " "	*	*	>6
Chromium " " "	<25	25-75	>75
Barium " " "	<20	20-60	>60
Copper " " "	<25	25-50	>50

*Lower limits not established

	POLLUTED
Mercury	≥ 1 mg/kg dry weight
Total PCB's	≥ 10 mg/kg dry weight

Table 5
Indiana Harbor Canal Sediments
November 7-13, 1979
(mg/kg)
U.S. Army Corps of Engineers, Chicago District

Station	Chemical Oxygen Demand	Total Kjeldahl Nitrogen	Ammonia Nitrogen	Total Phosphorus	Mercury	Lead	Zinc	Manganese	Nickel	Arsenic	Cadmium	Chromium	Magnesium	Copper	Iron	Total Solids	Volatile Solids %	Oil & Grease	Total PCB
Columbus Drive Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Indianapolis Blvd. Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
The Forks Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Canal Street Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dickey Place Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
New York Central RR South Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] RR North Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] North Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turn Basin South Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turn Basin Middle Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turn Basin North Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Channel Entrance - Middle Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Channel Entrance - South Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 6

GRAND CALUMET RIVER SEDIMENTS
(mg/kg)

December 3-4, 1980

USEPA - Great Lakes National Program Office

	Phenols	Cyanide	Iron	Nickel	Manganese	Cadmium	Chromium	Barium	Copper
Lake Street									
Max.	1.9	1.0	12000	6.7	1100	0.4	61	44	12
Min.	0.4	0.2	3600	2.6	270	<0.2	14	19	2.9
Avg.	1.1	0.7	6200	4.1	614	0.3	33	32	5.4
Bridge Street									
Max.	6.2	113.1	300,000	71	4500	5.7	88	110	150
Min.	3.3	81.5	37,000	22	950	1.6	19	91	91
Avg.	6.2	90.0	164,500	44	2970	3.2	61	97	110
Industrial Hy.									
			130,000	82	1100	< 2	220	40	190
			130,000	82	1100	< 2	220	40	190
			130,000	82	1100	< 2	220	40	190
Kennedy Ave.									
Max.	0.8	50.9	60,000	34	630	31	180	99	490
Min	0.4	<0.1	5,600	4	93	<0.2	19	13	2.5
Avg.	0.6	6.5	45,150	20	473	16	58	74	247
Indianapolis Blvd.									
Max.	6.1	533.0	310,000	890	3400	64	1300	270	440
Min.	1.0	21.9	23,000	140	390	10	360	120	270
Avg.	4.2	162.1	205,750	340	2140	26	620	210	353
Cline Ave.									
Max.	1.1	30.0	200,000	140	2000	< 2	390	97	170
Min.	1.1	30.0	200,000	140	2000	< 2	390	97	170
Avg.	1.1	30.0	200,000	140	2000	< 2	390	97	170
151st Street									
Max.	1.4	34.9	63,000	65	630	11	730	92	150
Min.	1.4	34.9	63,000	65	630	11	730	92	150
Avg.	1.4	34.9	63,000	65	630	11	730	92	150
Columbus Drive									
Max.	2.8	141.6	270,000	190	4200	13	2000	160	250
Min	0.6	20.4	130,000	44	1900	2.9	470	95	120
Avg.	1.4	56.0	215,000	191	3047	9	1140	125	220

	Aluminum	Zinc	Lead	Tin	Titanium	Arsenic	Total Solids %	Volatile Solids %
Lake Street								
Max.	3900	300	37	42	170	15	83.0	2.8
Min.	1700	31	< 7	<4	80	6.1	79.4	1.4
Avg.	2760	87	18	11	140	10.5	81.7	2.0
Bridge Street								
Max.	11,000	5000	1200	55	340	28	56.4	60.9
Min.	3,300	1100	650	33	130	9.3	48.2	8.8
Avg.	7,200	3000	784	40	225	22	52.1	27.6
Industrial Hy.								
	2,200	1100	400	140	80	19	57.7	8.6
	2,200	1100	400	140	80	19	57.7	8.6
	2,200	1100	400	140	80	19	57.7	8.6
Kennedy Ave.								
Max.	12,000	1400	4000	95	87	32	83.3	24.9
Min	2,000	19	9	<4	25	4.3	23.7	1.4
Avg.	7,600	622	1177	33	59	21.3	46.6	14.7
Indianapolis Blvd.								
Max.	18,000	5000	15,000	1500	310	93	41.7	20.6
Min.	6,600	2700	830	200	140	37	22.0	17.9
Avg.	12,400	4225	4,750	665	213	54	32.7	19.1
Cline Ave.								
Max.	6,100	2200	360	190	170	21	51.4	14.4
Min.	6,100	2200	350	190	170	21	51.4	14.4
Avg.	6,100	2200	360	190	170	21	51.4	14.4
151st Street								
Max.	6,600	2600	650	400	170	38	64.6	6.7
Min.	6,600	2600	650	400	170	38	64.6	6.7
Avg.	6,600	2600	650	400	170	38	64.6	6.7
Columbus Drive								
Max.	8,000	13,000	2100	2300	210	40	76.9	19.9
Min	4,800	3,300	580	430	130	14	37.1	2.3
Avg.	6,400	7,583	1400	1100	180	33	52.8	13.7

Table 6
(cont.)
GRAND CALUMET RIVER SEDIMENTS
(mg/kg)

December 3-4, 1980

	Ammonia	Total Kjeldahl Nitrogen	Total Phosphorus	Chemical Oxygen Demand	Mercury	Total Solids	Volatile Solids	PCB	Oil & Grease
Lake Street									
Max.	39	430	130	21400	0.01	83.0	2.8	2.6	2100
Min.	24	150	110	7300	0.01	79.4	1.4	1.1	<650
Avg.	31	268	124	12640	0.01	81.7	2.0	1.8	1190
Bridge Street									
	200	2000	1400	161800	1.20	56.4	80.9	16.0	80500
	44	970	550	69200	0.06	48.2	8.8	4.4	9700
	114	1614	900	118660	0.51	52.1	27.0	9.4	41820
Industrial Hwy.									
	510	1700	670	79800	0.08	57.7	8.6	9.0	50800
	510	1700	670	79800	0.08	57.7	8.6	9.0	50800
	510	1700	670	79800	0.08	57.7	8.6	9.0	50800
Kennedy Ave.									
	230	10000	1900	298500	12.00	83.3	24.9	7.2	23100
	35	560	110	16700	0.13	23.7	1.4	1	<650
	154	5065	1303	166650	3.1	46.6	14.7	2.5	8137
Indiannapolis Blvd.									
	1100	6300	7800	253400	2.20	41.7	20.6	33.0	80000
	790	3600	1500	236800	0.30	22.0	17.9	1	6800
	1023	4550	3475	245425	1.22	32.7	19.1	7.0	45450
Cline Ave.									
	200	1400	2300	96300	0.21	51.4	14.4	7.9	22400
	200	1400	2300	96300	0.21	51.4	14.4	7.9	22400
	200	1400	2300	96300	0.21	51.4	14.4	7.9	22400
151st Street	240	840	1200	48800	0.08	64.6	6.7	10.0	31100
	240	840	1200	48800	0.08	64.6	6.7	10.0	31100
	240	840	1200	48800	0.08	64.6	6.7	10.0	31100
Columbus Drive									
	1000	3800	6400	209400	1.00	76.9	19.9	56.0	76600
	250	610	570	21600	0.21	37.1	2.3	12.0	5800
	664	2601	3967	151300	0.61	52.8	13.7	33.3	47214

However, highest concentrations of PCBs generally occurred in the lower halves of the cores in the IHC north of Columbus Drive (1979 COE data), whereas, PCB levels were highest in the top or middle sections of the cores in the Grand Calumet River (1980 EPA data). Different core sectioning intervals between the EPA and COE sampling surveys make more direct comparisons impossible.

The complex flow patterns in the GCR-IHC system result in highly variable rates of sedimentation in various parts of the system. This variability and the very high density of discharges along the system obscure the sediment contamination "fingerprints" of individual point sources, resulting in an agglomeration of sediment contamination beginning immediately downstream of the headwaters of the GCR (Lake Street sampling site) with highest contamination in apparent depositional areas. Based upon the 1980 EPA survey, the east arm of the GCR is generally scoured by high flows from Bridge Street to the vicinity of the junction of the east and west arms of the GCR (Kennedy Avenue and Indianapolis Blvd. sampling sites). From that point north in the IHC appears to be another area of scour until the beginning of the dredged part of the IHC (Columbus Drive sampling site) where sediments again settle out. The highest levels of sediment contamination in the 1980 EPA survey were found in these depositional areas.

Concentrations of most contaminants in the 1980 EPA survey were highest within the top one foot of the core samples. The only notable exceptions were that iron concentrations generally peaked in the second foot of the cores; and PCBs were fairly randomly distributed in the cores but tended to be highest within the top two feet of the cores.

The amount of sediment compaction that occurred in the cores when the samples were taken is not known. Therefore, it is not known whether the vertical sections in the core (basically at one foot intervals) represent one foot intervals of *in situ* sediments. Nevertheless, the data tends to show the relative layering of contaminants. In a less complex and disturbed system, the higher levels of contamination toward the surface of the cores would mean high levels of recent contaminant inputs. In the GCR-IHC system, although this conclusion is not as clear-cut, the data tend to support a hypothesis of continuing input.

Because the Indiana Harbor Canal sediments are so polluted, maintenance dredging in the area has not been performed since 1976 for lack of a dredge disposal site. As a result, deep draft traffic is no longer possible in the Grand Calumet Branch (5).

Based upon a 1977 USEPA study of the Indiana Harbor Canal, the sediments at Indianapolis Blvd., Columbus Drive, the Forks (confluence of Grand Calument Branch and Lake George Branch), and Canal Street were observed to contain as much as 1800 ppm of certain polynuclear aromatic hydrocarbons (PAH) (see Table 7). Included was the highly carcinogenic benz(a)pyrene observed at 50 ppm at the Columbus Drive station. In a 1972 USEPA study (see Table 8), oil and grease extracts from sediments from the east arm of the Grand Calumet River were subjected to PAH analysis, particularly for benz(a)pyrene, phenanthrene, and anthracene. Most of the sediment samples were taken from the stream bottom bordering U.S. Steel property. Other samples were taken from Industrial Highway and Cline Avenue. As much as 5300 ppm of phenanthrene and anthracene were found in the U.S. Steel area and benz(a)pyrene was observed at 380 ppm in the same samples. While these are the

Table 7

Polynuclear Aromatic Hydrocarbons

Indiana Harbor Canal Sediments

1977

Columbus Drive

Compound	Conc. ppm
Biphenyl	4
Naphthalene	4
Methylnaphthalenes (2 isomers)	7
Dimethyl naphthalenes or ethyl naphthalenes (5 isomers)	13
Benzo bicyclo diene	6
Anthracene	17
Phenanthrene	4
Fluoranthene	43
Pyrene	54
Dimethyl phenanthrene	2
Benzofluorene	0.8
Methylpyrene	0.6
others-molec. weight (228)	6
Trimethyl naphthalenes (7 isomers)	30
[1]Benz (e) pyrene or Benz (A) pyrene or benzofluoranthene or perylene	30

The Forks

Compound	Conc. ppm
Naphthalene	2
methylnaphthalene	2
dimethylnaphthalene or ethyl naphthalene (3 isomers)	12
Trimethylnaphthalene (6 isomers)	30
7-8 benzobicyclo (-2-2-2) octa 2-5 diene	30
Phenanthrene or Anthracene	36
methyl phenanthrene or methyl anthracene (3 isomers)	14
Fluoranthene	27
pyrene	81
dimethyl phenanthrene or dimethyl anthracene (2 isomers)	3
Benzofluorine or methyl pyrene (3 isomers)	3
Benzanthracene or chrysene or thriphenylene or naphthacene or benzophenanthrene (2 isomers)	4

Canal Street

Compound	Conc. ppm
Naphthalene	6
methylnaphthalene (2 isomers)	6
Ethyl naphthalene or dimethyl naphthalene (3 isomers)	14
Isopropyl or trimethyl naphthalene (5 isomers)	30
Biphenyl	5
7-8 benzobicyclo (2-2-2) octa -2-5 diene	7
Anthracene	18
Phenanthrene	4
methyl anthracene or methyl phenanthrene	12
dimethyl phenanthrene or dimethyl anthracene (2 isomers)	3
ethyl phenanthrene or ethyl anthracene (2 isomers)	2
Fluoranthene	16
Pyrene	16
Benzofluoranthene or methyl pyrene (4 isomers)	26
Perylene or benzofluoranthene or benzpyrene	38

Indianapolis Boulevard

Compound	Conc. ppm
methylnaphthalene (2 isomers)	237
dimethyl naphthalene or ethyl naphthalene (5 isomers)	1847
Trimethylnaphthalenes (8 isomers)	2180
Phenanthrene methyl anthracene or methyl phenanthrene (4 isomers)	300
Fluoranthene	22
pyrene	44
dimethyl phenanthrene	33

Table 8

Polynuclear Aromatic Hydrocarbons

Grand Calumet River (East Arm) Sediments

1972

Number Feet Downstream from Culvert *	mg/kg Dry Sample Weight of Benz(a)pyrene	mg/kg Dry Weight of Phenanthrene and Anthracene
100	1	40
100	10	
100	2	
500	39	
2100	7	
3300	200	100
4560	66	2000
6975	380	1540
8700	77	
10800	5	5300
12900	8	470
12900	2	50
26900	10	80
26900	19	230
35600	5	
35600	4	11

* Culvert is located at headwaters of East Arm I (see Fig. 1)

only stations for which these types of data are available, PAH contamination most likely can be expected throughout the system.

Data from the 1977 study also indicate that the sediments from the same four IHC stations above were virtually devoid of benthic life (see Table 9). Populations at the remaining sampling sites of the Canal lakeward were heavily dominated by Oligochaetes, however, near sterile conditions were again observed in the turning basin. Although the absence of macro-invertebrate populations in the Grand Calumet River sediments, due to toxicity and improper substrate, is most likely a certainty (9), this condition has never been documented.

A recently completed USEPA study of the GCR-IHC (Appendix C) confirms the sediment and water quality data assembled for this review.

V Fish Monitoring (11).

Prior to 1980, fish collection efforts in the GCR-IHC were unsuccessful due to poor water quality, inappropriate fishery habitat, and limited access for the successful deployment of fish shocking apparatus. The first two factors restrict the type and abundance of fishes which can survive and propagate in the area, the third factor restricts the ability of fishery personnel to collect them. Fish samples were collected from the area on two separate occasions in 1980, and the later sample subjected to analysis for pesticides, PCB, and metals (see Table 10). All of the values were very low, approaching detection limits in most cases. None of the values exceeded the action levels for PCB's, pesticides , or mercury used by the U.S. Food and Drug Administration (USFDA). Although these action levels are used by the USFDA to determine whether fish fillets are fit for commercial markets, the levels are commonly employed by other agencies to assess the severity of fish contaminant problems.

Use of the fish contaminant results to assess water quality, sediment quality, and/or repositories for toxicant bioaccumlation potential would be highly untenable. Importantly, it could not be determined whether the specimens were truly representative of the area (resident) since only large individuals were observed at the time of shocking on the first occasion (July). It is suspected that these individuals

MACROINVERTEBRATES

Table 9

HARBOR: Indiana Harbor, Indiana

SAMPLED: August 30, 1977

NUMBER OF ORGANISMS FOR EACH TAXA

TAXA	Columbus Drive	Indianapolis Blvd.	The Forks	Canal Street	Dickey Road	NYCRR	EJ & E RR	Canal Mouth	Turn Basin South	Turn Basin Middle	Turn Basin North	Channel Entrance Middle	Channel Entrance Mouth
DIPTERA													
Chironomus	9												2
Micropsectra	1												
Microtendipes	1												
Dicrotendipes	2								1				
Kiefferulus	2												
Procladius	3											1	
Brillia	1												
Chaoborus		1											
Cryptochironomus												1	2
Trichocladius													3
OLIGOCHAETA													
Tubifex	77				210	39	76	1,400	27	43	176	375	31
Limnodrilus	64				281	20	95	299	5	4	23		
Peloscolex	3				23		43	630	9	20	31		3
Branchiura sowerbyi								10					
Unidentifiable immature					45	8	24	150		30	35	25	8
HIRUDINEA													
Glossiphonia							1						3
Mooreobdella											1		
Dina													1
Helobdella													4
AMPHIPODA													
Gammarus													1
PELECYPODA													
Pisidium				1									
Sphaerium				3		6	17	41	7	33	8		83
Musculium								17			3		13
GASTROPODA													
Lymnaea			1	2					2				2
Physa			1	4		21	4	16	48		8		4
Goniobasis				1	1			2					
Helisoma										3	1		
Gyraulus													7
Total number of organisms	163	1	2	11	560	114	260	2,576	99	133	306	402	171
Total number of taxa	10	1	2	5	5	5	7	9	7	6	9	4	13

Table 10

Chemical Analysis of
GCR-IHC Fish

Sample characteristics

Collector: Indiana State Board of Health
Analysis: Indiana State Board of Health

Species:	Carp
Collection Date:	10/7/80
Sample type:	Whole fish
Total number of fish:	5 (composited)
Mean length (range)	16.4 mm (11.6-26.8)
Mean weight (range)	100 g. (22-280)
% Lipids:	1.74 %

Contaminant Data (Whole fish basis) ppm

PCB:	1.421
Hexachlorobenzene:	0.002
Pentachloroanisole:	0.003
Cis-nonachlor:	0.001
Cis-chlordane:	0.006
Trans-chlordane:	0.008
Oxychlordane:	0.001
DDT's (Total):	0.020
Dieldrin:	0.001
BHC (alpha):	0.001

Arsenic:	0.19
Cadmium:	0.10
Chromium:	0.85
Copper:	1.38
Lead:	0.20
Mercury:	0.025

Heptachlor	Not detected
Heptachlor epoxide	Not detected
Trans-nonachlor	Not detected
Aldrin	Not detected
Methoxychlor	Not detected
Endrin	Not detected
Benzene hexachloride	Not dectected

were merely passing through the area. On the second occasion (October) only small specimens were observed and five with a total weight of approximately one pound were collected. It is possible that these small fish may have been subject to involuntary displacement due to storm-induced high flows and and velocities. Since no gradation in size or age was observed in the fish samples, a positive GCR-IHC residency confirmation for the observed specimens and any cause/ effect relationships were impossible. Perhaps the most important implication to be drawn from the successful shocking procedure is that water quality has improved in the Canal to the point where at least rough fish can survive for some duration.

VI Problem Areas

While the entire Grand Calumet River-Indiana Harbor Canal is a problem area, there are certain sub-areas that are more of a problem than others because of gross contamination with toxics and hazardous materials. "Hot Spots" and causes based upon sediment analysis include:

(1) PCB - IHC, Columbus Drive to the New York Central RR (NYCRR) crossing
(2) Benz(a)pyrene - IHC - Columbus Drive
(3) Benz(a)pyrene and other PAHS - GCR - U.S. Steel Area
(4) other PAHS - IHC - Lake George Branch - Indianapolis Boulevard
(5) Ammonia- IHC - Columbus Drive, The Fork
(6) Iron - Entire GCR-IHC system except Lake Street
(7) Nickel - Entire system except canal mouth, turn basin north, entrance channel mouth, Lake Street and Kennedy Avenue
(8) Manganese - Entire system except turn basin north, entrance channel mouth
(9) Mercury - IHC - Columbus Drive, Indianapolis Boulevard, the Fork, Canal Street, NYCRR (No mercury data on GCR)
(10) Lead - Entire system except turn basin north, entrance channel mouth and Lake Street
(11) Zinc - Same as 10

(12) Arsenic - Entire system

(13) Copper - Entire system except turn basin north, entrance channel mouth and Lake Street

(14) Chromium - Entire system except canal mouth, turn basin north, channel entrance mouth, Lake Street and Bridge Street

(15) Cadmium - Entire system except canal mouth, turn basin south, turn basin north, and channel entrance mouth, Lake Street, Bridge Street, Indianapolis Boulevard and Cline Avenue

VII Location of Major Municipal and Industrial Discharges

The locations of the dischargers to the GCR-IHC are shown in Figure 1 and listed in Table 1. The major dischargers within the Indiana Harbor turning basin and the Indiana Harbor Canal are Inland Steel and Jones-Laughlin Steel. Major dischargers to the Lake George Branch, the Indiana Harbor Canal south of the Lake George Junction, and the Grand Calumet River east of the junction with the Indiana Harbor Canal, represent a variety of industries. These include refineries (Cities Service, Energy Cooperative, Inc.), foundries (Blaw-Knox), chemical plants (DuPont, Union Carbide) and steel plants (U.S. Steel).

There are two municipal secondary sewage treatment plants in the study area. These are East Chicago (20 MGD) and Gary (60 MGD). Hammond (48 MGD) may also discharge intermittently into the study area during periods of high rainfall.

Other discharges into the river are mainly from combined sewer systems. When a rainfall of 0.1 inches or greater in 24 hours occurs, the Hammond, East Chicago, and Gary wastewater treatment plants must bypass untreated industrial and domestic wastewater to the Grand Calumet River (1). In addition more than a dozen storm sewers carrying urban run-off (streets, parking lots, etc.) discharge to the system.

VIII Potential Problem Sources

Organic toxicants were not addressed in the original issuance of NPDES permits to industrial facilities in the GCR-IHC system because the effluent character was not completely defined by the discharger, the analytical capability to measure small concentrations was not reliable, and specific treatment technology was not available. However, the permit conditions that were applied, BPCT (Best Practical Control Technology) and in some instances treatment approaching BAT (Best Available Treatment) for conventional pollutants and some metals, resulted in a major improvement in effluent quality and also more than likely reduced the concentration of any organic toxicants being discharged.

The original NPDES permits are currently expiring. To re-apply all dischargers are required to submit form "2C" which will include an effluent analysis for the 129 priority pollutants. This information is intended to assure that the re-issued permits will address specific toxicant limits where necessary. In this manner any industry currently discharging toxicants directly to the GCR-IHC will be controlled upon the implementation of the reconditioned permit.

The municipal dischargers, however, will continue to remain a potential problem source until such time as the pretreatment program becomes fully effective in it's control of industrial influents to municipal collection systems. By far the most significant water quality problem in the GCR-IHC is the presently uncontrolled discharge by industries to the East Chicago and Gary sewage systems.

Listed below are all industries and municipalities discharging directly to the GCR-IHC and the 1980 status of permit compliance. Also included is a list of the closely proximate landfills and dumps, wastewater impoundments, and a discussion of the potential effects of impoundment seepage as a contribution to GCR-IHC pollution

Municipalities

Based upon the Northwest Indiana 208 Water Quality Management Study, the three municipal dischargers to the system (East Chicago, Gary, Hammond) all have at least fifty (50) industries, some with and some without pretreatment, discharging to respective sanitary sewers (1). As a result, the municipal discharges to the GCR-IHC would be expected to contain toxic materials of the type contaminating the system.

However, a USEPA toxicant study of the East Chicago Wastewater Treatment Plant (WWTP) effluent on January 29, 1980 revealed only very small concentrations of non-volatile organic toxicants and heavy metals, although a bioassy of the same effluent was acutely toxic to minnows and Daphnia, and an "AMES" test was positive for mutagenicity. It was concluded that the acute toxicity and mutagenicity were caused by synergistic concentrations of cyanide and phenols.

The latest compliance monitoring for dischargers in the area shows:

(1) East Chicago - not in compliance with permit conditions. BOD and total suspended solids violations.

(2) Gary - in compliance

(3) Hammond - (discharges intermittently into the GCR-IHC system during periods of high rainfall). In compliance with permit conditions.

Industries (Major Direct Dischargers)

(1) DuPont - In compliance with permit conditions.
(2) Energy Cooperative Inc. - In compliance with permit conditions. Not currently operating.
(3) Inland Steel - In compliance with permit conditions. Some erratic total suspended solids violations.
(4) Union Carbide - In compliance with permit conditions.
(5) Jones-Laughlin-Steel - In compliance with permit conditions.
(6) U.S. Steel - In compliance with permit conditions.

Industries (Minor Direct Dischargers)

(1) Cities Service Oil - At one time a large refinery in the area. Currently, however, the facility is in the process of being closed.
(2) Phillips Pipeline Co. - This gasoline terminal is in compliance with permit conditions.
(3) Blaw-Knox Foundry - In compliance with permit conditions.
(4) Harbison - Walker Refractories - In compliance with permit conditions.

Landfills and Dumps

Landfills and dumps contiguous or in close proximity to the study area, that may be contributing to pollution of the GCR-IHC through leachate to groundwaters or run-off during precipitation events, are shown in Table 11. While files exist for each landfill and dump listed, the included information is very sketchy at best, and appropriate characterizations of disposal areas have not been made, nor is it feasible in most cases to do so. Based upon available data, it is impossible to determine whether these disposal areas are contributing to GCR-IHC pollution. Some regulatory activity has been initiated under both the Resource Conservation and Recovery Act and the Federal Water Pollution Control Act. Table 13 summarizes the status of enforcement actions ~~in the~~ area under these Acts.

Table 11

Landfills and Dumps

1.	American Recovery Company	(East Chicago)
2.	Conservation Chemical Company	(Gary)
3.	East Chicago Dump	(East Chicago)
4.	DuPont Co.	(East Chicago)
5.	Flexiflo	(Gary)
6.	Gary Land Development Company	(Gary)
7.	General American Transportation Corporation	(East Chicago)
8.	Old Slag Dump	(Gary)
9.	Samocki Brothers	(Gary)
10.	Union Carbide	(East Chicago)
11.	Vulcan Materials	(Gary)

Pits, Ponds, Lagoons

Based upon the 1978 Surface Impoundment Assessment (SIA) Study performed under the aegis of the Underground Inspection Control Program of the Office of Drinking Water, 26 surface impoundments were located (see Table 12) in the study area and the qualitative effects of these impoundments on ground water were evaluated (3). Twenty-five (25) of the 26 impoundments were constructed and operated without bottom liners for groundwater protection. In each and every case, including the impoundment lined with plastic materials, the study determined that significant adverse changes in ground water quality due to seepage from the impoundments was occurring. Since all impoundments are contiguous or in close proximity to the GCR-IHC, it logically can be expected that the impoundment seepage is also contributing to the pollution of the GCR-IHC. As received in Region V, the SIA study consisted of computorized print-outs giving owners names, locations, impoundment types, waste types, and conclusions drawn. No data were presented to characterize the contamination seeping from each impoundment.

IX Status of Facilities Plans and Construction Grants (10)

Gary Sanitary District

Sewage treatment facilities planning has been completed except for solids handling, and the expansion and upgrading to advanced waste treatment are well underway. The District has also completed facilities planning for unsewered areas, and a portion of the sewer system evaluation survey for large diameter sewers and sewers over 50 years of age. In addition, a combined sewer overflow study with East Chicago and Hammond has been completed, but not yet submitted for review. The District has applied for additional grant monies to study residual waste management. That study began August 1, 1981 and completion is anticipated by December 1982. Finally, the District is currently developing a pretreatment program.

Table 12

Surface Impoundment
Assessment Study
(Lake County - 1978)

Name	Number of Impoundments
Bryant Farms (Hebron)	1
William Auber Ranch (Hammond)	1
American Chemical Service (Hammond)	1
American Maize Company (Hammond)	1
Conservation Chemicals of Illinois (Gary)	1
Energy Cooperative Inc. (East Chicago)	1
Georgia-Pacific Inc. (Gary)	1
Hammond Lead Products (Hammond)	1
Inland Steel Corp. (East Chicago)	3
Jones-Laughlin Steel Corp. (East Chicago)	3
Lever Brothers Inc. (Hammond)	1
Chris-Craft (Gary)	1
North Indiana Public Service (Gary)	1
U.S. Steel Corp. (Gary)	5
Vulcan Materials (Gary)	1
East Chicago Sanitary District (East Chicago)	1
Gary Sanitary District (Gary)	1
Hammond Sanitary District (Hammond)	1

East Chicago Sanitary District

No substantial facilities planning has been completed. The District has received 1.4 million dollars in grants to develop a facilities plan. To date a district planning effort was returned because of major deficiencies. A sewer system evaluation survey was submitted by the District. Additionally a facilities planning segment to address rehabilitation of the existing sewage treatment plant was prepared and submitted by the District. However, major deficiencies exist and the segment was returned for updating. A combined sewer overflow study concurrent with studies by Hammond and Gary has been completed but not yet submitted for review. The District has applied for a grant amendment to develop a pretreatment program which was reviewed and returned because of major deficiencies.

Hammond Sanitary District

Facilities planning on the sewerage system is essentially complete. In late 1980, the infiltration-inflow study was approved and the Robertsdale Pumping Station and force main were constructed to eliminate combined sewer discharges to Lake Michigan. The District has completed a combined sewer overflow study with East Chicago and Gary and has received a grant amendment to conduct a sewer system evaluation survey in the Robertsdale area. As a condition of the Step 3 Grant, an industrial pretreatment program is being developed. A portion of that program has been completed and is currently at the State under review.

X Status of Enforcement Actions (6,8)

Table 13 enumerates enforcement actions pending in northwest Indiana. The actions have been initiated based upon regulations developed to implement the Resource Conservation and Recovery Act and thr Federal Water Pollution Control

Table 13

Status of Enforcement Actions

Northwest Indiana

August 1982

Resource Conservation and Recovery Act. (RCRA) (Section 3008)

By-Products Management (Shereville, Indiana) - Closed out, in compliance
Conservation Chemical (Gary, Indiana) - In settlement negotiations
Enamel Plating & Products (Portage, Indiana) - Administrative Order, closed out, in compliance
Mason Metals (Shereville, Indiana) - Closed out, in compliance
Synthetic Energy Products of America (East Chicago, Indiana) Closed out
American Chemical Service (Griffith, Indiana) - Closed out
Anderson Company (Gary, Indiana) - Closed out.

RCRA (Section 7003)

Midco #1 (Gary, Indiana) - Cleaned up under Superfund. Case pending for cost recovery
Midco #2 (Gary, Indiana) - Case pending
9th Avenue Dump, (Gary, Indiana) - Clean up schedule developed
Ken Industries (Hammond, Indiana) - Case settled, company has completed clean up
KOR Corporation (Gary, Indiana) - Case pending, but inactive, owners are bankrupt
Lloyd Hodges (East Chicago, Indiana) - Majority of waste has been removed, partial consent decree signed, case pending.

Federal Water Pollution Control Act (Section 309)

East Chicago Sanitary District (East Chicago, Indiana) - Under suit in U.S. District Court. State of Indiana and USEPA co-plaintiffs.
Hammond Sanitary District (Hammond, Indiana) - Under suit in U.S. District Court. State of Indiana and USEPA co-plaintiffs. Consent decree has been drafted.
Samocki Brothers (Gary, Indiana) - Case closed. Samocki Brothers has been issued a permit by State of Indiana.
Gary Sanitary District (Gary, Indiana) - In the process of signing the judicial consent decree.
Energy Cooperative (East Chicago, Indiana) - Still negotiating on a consent decree.

Act. Four of the listed enforcement actions pertain to the Grand Calumet River - Indiana Harbor Canal Basin. These include the three (3) municipalities, Gary, East Chicago, and Hammond and Energy Cooperative, Inc. (ECI) of East Chicago. The action against ECI was taken to enforce compliance with section 301 requirements of the FWPCA for water quality limited segments. Rather than meet those requirements ECI decided to close it's facilities in the area. This process is ongoing and not as yet completed. When completed all enforcement activity against ECI will be terminated.

With respect to the Gary Sanitary District, a consent decree has been readied and is awaiting final sign off. The Sanitary District has agreed to the remedial program proposed and will sign the decree in the very near future. The State will also provide that no monetary penalties are assessed the District. While the final permit requirements will be fairly stringent (carbonaceous BOD - 11.5 mg/l monthly average, 20.5 mg/l weekly maximum; BOD total - 16 mg/l monthly average, 24 mg/l weekly maximum; suspended solids - 16 mg/l monthly average, 24 mg/l weekly maximum, total phosphorus - 0.2 mg/l monthly average, 0.4 mg/l weekly maximum) no requirements for toxic monitoring are included.

Hammond has completed construction of a large diameter forced main in a remedial program designed to eliminate combined sewer overflow to Lake Michigan.

USEPA and the State of Indiana are co-plaintiffs with the State of Illinois in a lawsuit against East Chicago. Currently one court order is in effect and the parties are negotiating for additional sewage treatment plant improvements.

XI Conclusions

(1) The GCR-IHC system violates the water quality standards (WQS) more frequently any other Indiana stream in spite of the fact that the GCR-IHC is classified as a limited use water body which is defined by more liberal standards.

(2) The WQS being violated include dissolved oxygen, fecal coliforms, total dissolved solids, chlorides, sulfates, phosphorus, oil and grease, ammonia nitrogen, cyanide, phenols and mercury. Should WQS for other constituents in the system be adopted, they most likely would be contravened also.

(3) The WQS for toxicants is defined as one-tenth of the median tolerance limit for important indigenous species. Aquatic life historically indigenous to the GCR-IHC has been absent for years because toxic conditions in the system are not conducive to it's sustenance.

(4) The huge quantities of cooling water discharged to the east arm make ambient water quality in the east arm less polluted than that in the west arm, even though total pollutional loads to both arms may be comparable.

(5) The GCR-IHC system has enormous quantities of benthal deposits - as much as 12 feet in some areas - containing high concentrations of toxic constituents including PCB, polynuclear aromatic hydrocarbons (PAH), mercury, lead, zinc, arsenic, cadmium, chromium, and other metals. In addition, the sediments include high concentrations of oil and grease, phosphorus, nitrogen, iron, manganese, magnesium, volatile solids, and chemical oxygen demand.

(6) The greatest PCB sediment pollution occurs in the Indiana Harbor Canal upstream of Columbus Avenue and extending lakeward to about the New York Central Railroad crossing. The highest PCB concentration observed in the IHC was 89.2 mg/kg found in the bottom half of a core taken at the NYCRR site.

(7) The IHC sediments at Indianapolis Boulevard, Columbus Drive, the Fork, and Canal Street were observed to contain as much as 1800 mg/kg of certain PAHs including the highly carcinogenic benz(a)pyrene at 50 mg/kg at the Columbus Drive site.

In the GCR as much as 5300 mg/kg of PAHs were found in the vicinity of U.S. Steel Corp. and benz(a)pyrene was observed at 380 mg/kg in the same area.

(8) The IHC sediments were observed to be nearly devoid of benthic life. Where life existed it consisted of small populations of the highly pollution-tolerant Oligochaete. While the absence of benthic life in the GCR due to toxicity and inappropriate substrate is most likely a certainty, this condition has never been documented.

(9) Using USEPA Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments, the entire GCR-IHC system can be classified as heavily polluted.

(10) The entire GCR-IHC system is contaminated with respect to one toxicant or another.

(11) Due to a lack of gradation in size, age, and other characterisitcs, a definitive GCR-IHC residency confirmation of the fish specimens collected in the system was impossible. As a result the use of the fish contaminant data to assess water quality, sediment quality, and/or repositories for toxicant bio-accumulation potential would be highly untenable. Perhaps the most important implication to be drawn from the successful fish collection process is that the water quality in the Canal has improved to the point where at least the rough fishes can survive for some duration.

(12) The treatment required for conventional pollutants and metals most likely reduced much of any toxicant being discharged by industry.

(13) With Form "2C" all dischargers re-applying for permits are being required to analyze all respective effluents for the 129 priority pollutants.

(14) The municipal dischargers are, and will continue to remain, potential problem sources until the pretreatment program becomes fully effective in it's control of industrial influents to municipal collection systems.

(15) Based upon available data it is impossible to determine whether the closely proximate landfills and dumps are contributing to GCR-IHC pollution.

(16) At least 26 wastewater impoundments are located in the study area. Since all impoundments are either contiguous or fairly close to the GCR-IHC system, it can be expected that these impoundments can potentially contribute to the pollution of that system.

REFERENCES

(1.) Northwest Indiana 208 Water Quality Management plan, Northwest Indiana Planning Commission (1978).

(2.) Water Quality Monitoring Rivers and Streams, Indiana State Board of Health, Division of Water Pollution Control, Indianapolis, Indiana 1978, 1979, 1980

(3.) Surface Impoundment Assessment Study, Office of Drinking Water, USEPA, 1978

(4.) Personal communication, Mr. Steve Boswell, Indiana State Board of Health, Indianapolis, August 1981.

(5.) Personal communication, Mr. Ted Vergis, U.S. Army Corps of Engineers, Chicago, August 1981

(6.) Personal communication, Ms. Barabara Sidler, USEPA, Chicago, September 1981

(7.) Personal communication, Mr. Richard A. Craig, USGS, Indianapolis, Indiana 1981

(8.) Personal communication, Mr. Arnie Leder, USEPA, Chicago, September 1981

(9.) Personal communication, Mr. John Winters, ISBH, Indianapolis, August, 1981.

(10.) Memorandum to author, Grand Calumet River and Indiana Harbor Canal Facilities Plan, T.L. Bramscher, August 1981

(11.) Memorandum to author, Fish Monitoring - GCR-IHC, J. Clark, September 1981.

APPENDIX A

Other dischargers in the immediate vicinity that do not discharge directly into the GCR-IHC but directly into Lake Michigan, Wolf Lake, and Wolf Lake Channel include the following:

(1.) Lever Brothers (Hammond) - Wolf Lake

(2.) American Maize (Hammond) - Wolf Lake Channel

(3.) Union Carbide (Gary) - Lake Michigan

(4.) NIPSCOO (Gary) - Lake Michigan

(5.) Commonwealth Edison (Hammond) - Lake Michigan

(6.) AMOCO (Whiting) - Lake Michigan

(7.) Universal Atlas Cement (Gary) - Lake Michigan

(8.) U.S. Steel (Gary) - Lake Michigan

(9.) Marblehead Lime Company (Gary) - Lake Michigan

The prevailing flow of Wolf Lake and Wolf Lake Channel is away from the GCR-IHC and toward the Cal-Sag Channel through the Calumet River. All the dischargers listed above except Commonwealth Edison are in compliance with NPDES permit conditions. Dischargers to the Little Calumet River Basin were not considered in this study.

Appendix B

Water Quality Standards

330 IAC 2-2

Grand Calumet River and Indiana Harbor Ship Canal

Cited in: 330 IAC 2-2-1; 330 IAC 2-2-2; 330 IAC 2-2-4; 330 IAC 2-2-7; 330 IAC 2-2-8.

330 IAC 2-2-1 Application of rule
330 IAC 2-2-2 Nondegradation policies
330 IAC 2-2-3 Water use designation
330 IAC 2-2-4 Mixing zones
330 IAC 2-2-5 Water quality standards
330 IAC 2-2-6 Analytical procedures
330 IAC 2-2-7 Definitions
330 IAC 2-2-8 Severability of rule

330 IAC 2-2-1 Application of rule

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-4; IC 13-1-3-7; IC 13-7-7-5

Sec. 1. The water quality standards established by this Regulation *[330 IAC 2-2]* shall apply to all waters of the Grand Calumet River and the Indiana Harbor Ship Canal. For purposes of this Regulation *[330 IAC 2-2]*, the eastern-most point of the Grand Calumet River is defined as beginning at the outfall of the five-foot diameter conduit located near the southeast corner of Section 35, T37N, R8W, in Lake County, Indiana. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 1; filed May 26, 1978, 3:30 pm: 1 IR 96)*

330 IAC 2-2-2 Nondegradation policies

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-7; IC 13-7-4-1; IC 13-7-5-1

Sec. 2. Nondegradation Policies. The following policies of nondegradation are applicable to all waters of the Grand Calumet River and the Indiana Harbor Ship Canal:

(a) General. For all waters existing instream beneficial uses shall be maintained and protected. No degradation of water quality shall be permitted which would interfere with or become injurious to existing uses.

(b) Higher Quality Waters. All waters whose existing quality exceeds the standards established herein, as of the date on which this regulation *[330 IAC 2-2]* becomes effective, shall be maintained in their present quality unless and until it is affirmatively demonstrated to the Board that limited degradation of such waters is justifiable on the basis of necessary economic or social factors and will not interfere with or become injurious to any beneficial uses made of, or presently possible, in such waters. In making a final determination under this subsection, the Board shall give appropriate consideration to public participation and intergovernmental coordination.

(c) Any determination made by the Board, in accordance with Section 316(a) of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), concerning alternative thermal effluent limitations, will be considered to be consistent with the policies enunciated in this section.

(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 2; filed May 26, 1978, 3:30 pm: 1 IR 96)

330 IAC 2-2-3 Water use designation

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-7; IC 13-7-4-1

Sec. 3. Water Use Designation. The Board is cognizant that the Grand Calumet River and the Indiana Harbor Ship Canal predominantly comprise treated wastewaters and wastewaters of nonpoint source origin, such as stormwater overflow from the preponderantly urbanized area which these streams traverse, and that, historically, a major function of these streams has been the conveyance of waters of such character. Upon consideration of these factors as well as the unnatural character of these stream beds and the further recognition that, even if all wastewaters discharged to these streams are provided the highest degree of treatment technologically and economically feasible, these streams may not be capable at all times of sustaining a well-balanced fish community, the Board classifies the waters of the Grand Calumet River and the Indiana Harbor Ship Canal for partial body contact, limited aquatic life and industrial water supply. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 3; filed May 26, 1978, 3:30 pm: 1 IR 97)*

330 IAC 2-2-4 Mixing zones

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-7; IC 13-7-5-1

Sec. 4. Mixing Zones. (a) All water quality standards in this Regulation *[330 IAC 2-2]*, except those provided in subsection 5(a) *[330 IAC 2-2-5(a)]* below, are to be applied at a point outside of the mixing zone to allow for a reasonable admixture of waste effluents with the receiving waters.

(b) Due to varying physical, chemical, and biological conditions, no universal mixing zone may be prescribed. The Board shall determine the mixing zone upon application by the discharger. The applicability of the guideline set forth in Section 4(c) *[subsection (c) of this section]* will be on a case-by-case basis and any application to the Board should contain the following information:

(1) The dilution ratio;

(2) The physical, chemical, and biological characteristics of the receiving body of water;

(3) The physical, chemical, and biological characteristics of the waste effluent;

(4) The present and anticipated uses of the receiving body of water;

(5) The measured or anticipated effect of the discharge on the quality of the receiving body of water;

(6) The existence of and impact upon any spawning or nursery areas of any indigenous aquatic species;

(7) Any obstruction of migratory routes of any indigenous aquatic species; and,

(8) The synergistic effects of overlapping mixing zones of the aggregate effects of adjacent mixing zones.

(c) Where possible the general guideline is to be that the mixing zone should be limited to no more than ¼ (25 percent) of the cross-sectional area and/or volume of flow of the stream, leaving at least ¾ (75 percent) free as a zone of passage for aquatic biota nor should it extend over ½ (50 percent) of the width of the stream. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 4; filed May 26, 1978, 3:30 pm: 1 IR 97)*

330 IAC 2-2-5 Water quality standards
Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-7; IC 13-7-4-1; IC 13-7-8-1

Sec. 5. Water Quality Standards. (a) Minimum Water Quality Conditions. All waters at all times and at all places, including the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil or scum attributable to municipal, industrial, agricultural, and other land use practices or other discharges:

(1) That will settle to form putrescent or otherwise objectionable deposits;

(2) That are in amounts sufficient to be unsightly or deleterious;

(3) That produce color, odor or other conditions in such degree as to create a nuisance;

(4) Which are in amounts that will be toxic or harmful to human, animal, plant or aquatic life; and,

(5) Which are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae in such a degree as to create a nuisance, be unsightly or deleterious or be harmful to human, animal, plant, or aquatic life or otherwise impair the designated uses.

(b) In addition to subsection 5(a) *[subsection (a) of this section]* above, the following standards are for protection of waters of the Grand Calumet River and the Indiana Harbor Ship Canal. They are applicable at any point in the stream outside the mixing zone:

(1) Toxic Substances. Concentrations of toxic substances shall not exceed one-tenth of the 96-hour median lethal concentration for important indigenous aquatic species. More stringent application factors shall be used, when justified, on the basis of available evidence and approved by the Board after public notice and opportunity for hearing.

(2) *Persistent or Bioconcentrating Substances.* Concentrations of organic contaminants which can be demonstrated to be persistent, to have a tendency to bioconcentrate in the aquatic biota, and are likely to be toxic on the basis of available scientific evidence, shall be limited as determined by the Board after public notice and opportunity for hearing. (Note: For subsections 5(b)(1) and 5(b)(2) *[subsection (b)(1) and this subsection]* the United States Environmental Protection Agency Administrator's Quality Criteria for Water will be among the documents used in establishing water quality standards for toxic and/or persistent substances.)

(3) pH. No pH values below 6.0 nor above 9.0, except daily fluctuations which exceed pH 9.0 and are correlated with photosynthetic activity, shall be permitted.

(4) Dissolved Oxygen. Concentrations of dissolved oxygen shall not be less than 4.0 mg/l at any time.

(5) Temperature.

(aa) There shall be no abnormal temperature changes that may adversely affect aquatic life unless caused by natural conditions.

(bb) Water temperature shall not, at the edge of the mixing zone, exceed the maximum limits in the following table:

Month	Grand Calumet River—Indiana Harbor Ship Canal °F (°C)
January	60 (15.6)
February	60 (15.6)
March	60 (15.6)
April	65 (18.3)
May	75 (23.9)
June	85 (29.4)
July	87 (30.6)
August	87 (30.6)
September	85 (29.4)
October	75 (23.9)
November	70 (21.1)
December	60 (15.6)

(6) Fecal Coliform Bacteria. The fecal coliform bacteria content (either MPN or MF count) shall not exceed a geometric mean of 1,000 per 100 ml, nor exceed 2,000 per 100 ml in more than ten percent of the samples, except during periods of stormwater runoff.

(7) Filterable Residue (total dissolved solids). The filterable residue content shall not exceed 500 mg/l at any time.

(8) Chemical Constituents. The following levels of chemical constituents shall not be exceeded at any time:

Constituent	Concentration	
Total Ammonia Nitrogen	1.5	mg/l
Cyanide	0.1	mg/l
Fluoride	1.3	mg/l
Iron (dissolved)	0.3	mg/l
Phenol	0.01	mg/l
Total Mercury	0.5	ug/l
PCB	0.001	ug/l

(9) Chlorides. The total chloride content shall not average more than 40 mg/l during any 12-month period nor exceed 125 mg/l at any time.

(10) Sulfates. The total sulfate content shall not average more than 75 mg/l during any 12-month period nor exceed 225 mg/l at any time.

(11) Total Phosphorus. The content of total phosphorus shall not exceed 0.10 mg/l at any time except in waters flowing westward into Illinois.

(12) Oil. Oil or similar materials shall not be present in such quantities that they will produce a visible film on the water surface, coat the banks and bottom of the stream or in any way be toxic or harmful to fish or other aquatic life. In addition, the total oil concentration shall not exceed 10.0 mg/l.

(13) Miscellaneous Trace Contaminants and Radionuclides. Miscellaneous trace contaminants and radionuclides shall not, after conventional treatment, be in such levels as to prevent meeting the Drinking Water Standards adopted by the Indiana State Board of Health or which may be adopted by the Environmental Management Board of the State of Indiana.

(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 5; filed May 26, 1978, 3:30 pm: 1 IR 97)

Cited in: 330 IAC 2-2-4.

330 IAC 2-2-6 Analytical procedures

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-8
Affected: IC 13-1-3-7; IC 13-7-5-1

Sec. 6. Analytical Procedures. The analytical procedures used as methods of analysis to determine the chemical, bacteriological, biological, and radiological quality of water samples shall be in accordance with 40 CFR Part 136, the latest edition of Standard Methods for the Examination of Water and Wastewater, or methods approved by the Indiana Stream Pollution

Control Board and the Environmental Protection Agency, Water Quality Office. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 6; filed May 26, 1978, 3:30 pm: 1 IR 98)*

330 IAC 2-2-7 Definitions

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-16; IC 13-7-1-2

Sec. 7. Definitions.

Application Factor—A numerical factor applied to the median lethal concentration to provide the concentration of a toxic substance that is considered to be safe for organisms in the waters of the state.

Average—Unless otherwise specified, the arithmetical average of a set of numbers.

Board—The Indiana Stream Pollution Control Board.

Effluent—A wastewater discharge from a point source to the waters of the state.

Fecal Coliforms—Coliform bacteria that produce gas from lactose in a special, buffered broth incubated at 45.5° C.

Mixing Zone—An area contiguous to a discharge where, as a result of said discharge, receiving water quality may not meet all water quality standards. Any time an effluent is added to a receiving waterway, where the effluent is poorer in quality, there will be a zone of mixing. The mixing zone should be considered a place where wastes and receiving waters mix and not as a place where effluents are treated.

Partial Body Contact—Any contact with water up to, but not including, complete submergence.

Point Source—A discernible, confined and discrete conveyance, from which wastewater is or may be discharged to the waters of the state.

Policy—As employed herein, a statement of administrative practice or decision-making guidelines to be followed or implemented to the maximum extent feasible with respect to an identified problematic situation but to be less than strictly enforceable in contrast to a standard or rule of law.

Standard—A definite numerical value or narrative statement promulgated by the Board to maintain or enhance water quality to provide for and fully protect a designated use of the waters of the state.

Toxic Substances—Materials which are or may become harmful to plant or animal life, or to food chains when present in sufficient concentrations or combinations.

Waters of the State—Such accumulations of water, surface and underground, natural and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this state, but the term does not include any private pond, or any off-stream pond, reservoir or facility built for reduction or control of pollution or cooling of water prior to discharge unless the discharge therefrom causes or threatens to cause water pollution.

Water Use Designations—A use of the waters of the state as established by this regulation *[330 IAC 2-2]*, including but not limited to industrial water supply, agricultural use, public water supply, total body contact, partial body contact, fish and other aquatic life. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 7; filed May 26, 1978, 3:30 pm: 1 IR 98)*

330 IAC 2-2-8 Severability of rule

Authority: IC 13-1-3-7; IC 13-7-5-1; IC 13-7-7-5
Affected: IC 13-1-3-18; IC 13-7-16-8

Sec. 8. Severability. If any section, paragraph, sentence, clause, phrase, or work of this regulation *[330 IAC 2-2]* or any other part thereof, be declared unconstitutional or invalid for any reason, the remainder of said regulation *[330 IAC 2-2]* shall not be affected thereby and shall remain in full force and effect. *(Stream Pollution Control Board of the State of Indiana; SPC 7R-3,Sec 8; filed May 26, 1978, 3:30 pm: 1 IR 99)*

APPENDIX C

A Report on

A Water Quality

Survey of

Grand Calumet River

Lake George Canal

Indiana Harbor Canal

Conducted by:

Central District Office

Analysis by:

Central Regional Laboratory

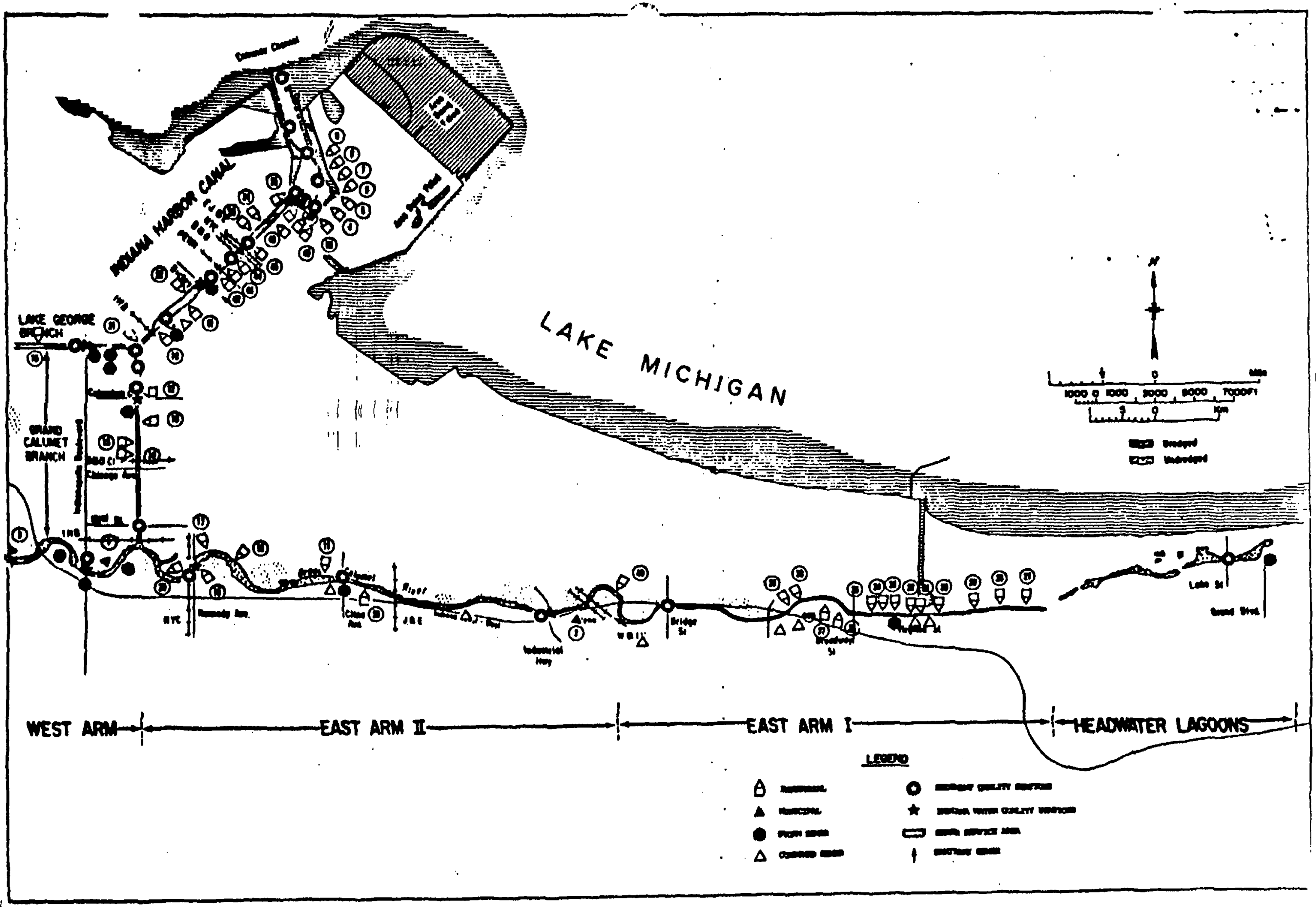
Introduction

The collection and analysis of environmental data to support abatement and control programs, such as the program to control toxic pollutants required by the National Resources Defense Council (NRDC) Settlement Agreement (June 7, 1978) is included in the water quality monitoring and analysis decision unit (B224). Toxics monitoring studies under paragraph 12 of the NRDC consent decree include exposure/risk studies to evaluate the levels of priority pollutants in the environment which may affect human health or aquatic life; fate studies to determine the fate of priority pollutants upon entering the environment; and dilution studies to identify specific areas where Best Available Technology (BAT) will not result in the attainment of water quality criteria for toxic pollutants.

The Regional responsibility to conduct such studies rests in the Environmental Services Division, with field resources in both the Central and Eastern District Offices. As part of the FY'81 decision unit B224 resource commitments, the Central District Office conducted a water quality study on the Grand Calumet River, Lake George Canal and Indiana Harbor Canal systems. (GCR-LGC-IHC)

Study Area

The study area is located in the northwest corner of Indiana. (See Figure 1). It is located entirely in Lake County, an area of intense industrial (steel and oil complexes) activity. Four major centers of population - East Chicago, Gary, Hammond and Whiting - are located in and around the GCR-LGC-IHC systems. The population in the area is in excess of 500,000. A



LAKE MICHIGAN
INDIANA HARBOR CANAL
LAKE GEORGE BRANCH
GRAND CALUMET BRANCH
Kennedy Ave.
Cline Ave.
Industrial Hwy
Bridge St
Broadway St
Virginia St
Lake St
Grand Blvd.
WEST ARM
EAST ARM II
EAST ARM I
HEADWATER LAGOONS
LEGEND
Dredged
Undredged

list of municipal and industrial dischargers is contained in Table 1.

The east branch of the GCR flows west about 13 miles after originating near a series of lagoons, west of the Marquette Park area in Gary, Indiana. It joins the IHC about 3 miles east of the Illinois border. The west branch of the GCR actually consists of two segments, separated by a natural divide near the Hammond-East Chicago corporate boundaries. Water in the east segment of the west branch flows east joining the east branch to form the IHC. Water in the west segment of the west branch usually flows westward into Illinois depending on weather conditions on Lake Michigan. The water entering the IHC flows approximately 5 miles to the north and northeast, before entering southern Lake Michigan. The LGC enters the IHC approximately 2 miles before the IHC enters Lake Michigan. In excess of 90 percent of the water flowing in this system enters as treated wastewater industrial cooling/process water or as overflow storm water.

Description of Survey

The water quality study was conducted on November 13, 1980. Samples were collected at four sites on the Grand Calumet River, at six sites on the Indiana Harbor Canal and two sites on the Lake George Canal (See Table 2 and Figure 2 for site descriptions and locations). Water grab samples were collected at all locations. Sediment samples were collected at six of the 12 sites (See Table 2) utilizing a ponar dredge. Electroshocking for fish collection was conducted in the Indiana Harbor Canal from the mouth of the Harbor to the IHB Railroad Bridge. One carp (cyprinus carpio) was collected from the IHC. No other fish were observed in the area. Flow data is

Table 1

POINT SOURCE DISCHARGERS WITHIN THE GRAND CALUMET RIVER AND INDIANA HARBOR CANAL

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
Municipal Dischargers				
1.	East Chicago	0022829	Grand Calumet River	WWTP Effluent
2.	Gary	0022977	Grand Calumet River	WWTP Effluent
3.	Hammond	0023060	Grand Calumet River	WWTP Effluent
Industrial Dischargers				
4.	Inland Steel Co.	IN 0000094 -013	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
5.	Inland Steel Co.	-014	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
6.	Inland Steel Co.	-015	Indiana Harbor Turning Basin	Process Water WWTP Effluent Cooling Water
7.	Inland Steel Co.	-016	Indiana Harbor Turning Basin	Process Water WWTP Effluent Cooling Water
8.	Inland Steel Co.	-017	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
9.	Inland Steel Co	-018	Indiana Harbor Turning Basin	Process Water Cooling Water Storm Water
10.	Union Carbide (E. Chicago)	IN 0000043	Indiana Harbor Canal/ Lake Michigan	Cooling Water
11.	Cities Service Oil Co. (E. Chicago)	IN 0000159	Grand Calumet River	Cooling Proces
12.	Phillips Pipeline Co. (E. Chicago)	IN 0032999	Indiana Harbor Canal/ Lake Michigan	Cooling Proces
13.	Blaw-Knox Foundry & Mill Machinery, Inc (E. Chicago)	IN 032549 -001	Indiana Harbor Canal/ Lake Michigan	Quench Water
14.	Blaw-Knox Foundry	-002 -003	Indiana Harbor Canal/ Lake Michigan	Storm Water Ground Water Cooling Water
15.	Harbison-Walker Refractories Co. (Hammond)	IN 0000248	Grand Calumet River	Cooling Water

Table 1
(Cont.)

POINT SOURCE DISCHARGES WITHIN THE GRAND CALUMET RIVER
AND INDIANA HARBOR CANAL (Cont.)

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
16.	E. I. duPont deNemours & Co. (E. Chicago)	IN 0000329 -001	Grand Calumet River	Cooling Water
17.	E.I. duPont deNemours	-002 -003	Grand Calumet River	Process Water Process Water
18.	C. F. Petroleum (E. Chicago) (Energy Cooperative, Inc.)	IN 0000051	West Branch/Indiana Harbor Canal/ Lake Michigan	Cooling, Process, Ballast & Storm Water
19.	America Steel Foundries	IN 0000167	Indiana Harbor Canal/ Lake Michigan	Process Water Cooling Water
20.	U.S. Lead Refiner (E. Chicago)	IN 0032425	Grand Calumet River	Process Water Cooling Water
21.	Jones and Laughlin Co. (E. Chicago)	IN 0000205 -001	Indiana Harbor Canal/ Lake Michigan	Process Water WWTP Effluent
22.	Jones and Laughlin Co.	-002	Indiana Harbor Canal/ Lake Michigan	Cooling (Cold rolling)
23.	Jones and Laughlin Co.	-009	Indiana Harbor Canal/	Cooling Water Power House
24.	Jones and Laughlin Co.	-010	Indiana Harbor Canal/	Cooling -
25.	Jones and Laughlin Co.	-011	Indiana Harbor Canal/ Lake Michigan	Process Water Cooling Water Mills & Hearths
26.	Petroleum Coke Calciner Kaiser Alum. & Chem. Corp. (Gary)	IN 0000141	Grand Calumet River	Cooling Water
27.	U.S. Steel Corp. Gary Works (Gary)	IN 0000281 -002 (GW-1) -005 (GW-1A)	Grand Calumet River	Process Water Cooling Water
28.	U.S. Steel Corp.	-007(GW-2)	Grand Calumet River	Cooling Water
29.	U. S. Steel Corp.	-010(GW-3)	Grand Calumet River	Cooling Water
30.	U.S. Steel Corp.	015(GW-4)	Grand Calumet River	Cooling Water

Table 1
(Cont.)

POINT SOURCE DISCHARGERS WITHIN THE GRAND CALUMET RIVER
AND INDIANA HARBOR CANAL (Cont.)

Discharge Number	Treatment Facility	Indiana NPDES No.	Receiving Stream	General Discharge Type
31.	U.S. Steel Corp.	-017(GW-5)	Grand Calumet River	Process Water Cooling Water
32.	U.S. Steel Corp.	-018(GW-6)	Grand Calumet River	Cooling Water
33.	U.S. Steel Corp.	-019(GW-7)	Grand Calumet River	Cooling Water
34.	U.S. Steel Corp.	-020(GW-7A)	Grand Calumet River	Process Water Cooling Water
35.	U.S. Steel Corp.	-021(GW-9)	Grand Calumet River	Cooling Water
36.	U.S. Steel Corp.	IN 0000281 -028(GW-10A)	Grand Calumet River	Process Water Cooling Water
37.	U.S. Steel Corp.	-030(GW-11A)	Grand Calumet River	Process Water Cooling Water
38.	U.S. Steel Corp.	-032(GW-13)	Grand Calumet River	Cooling Water
39.	U.S. Steel Corp.	-033(ST-14)	Grand Calumet River	Cooling Water
40.	U.S. Steel Corp.	-034(ST-17)	Grand Calumet River	Process Water Cooling Water
41.	Inland Steel Co. (E. Chicago)	IN 0000095 -001	Indiana Harbor Canal	Process Water Cooling Water Storm Water
42.	Inland Steel Co.	-002	Indiana Harbor Canal	Process Water Cooling Water Storm Water
43.	Inland Steel Co.	-003	Indiana Harbor Canal	Process Water Cooling Water
44.	Inland Steel Co.	-005	Indiana Harbor Canal	Process Water Cooling Water Storm Water
45.	Inland Steel Co.	-007	Indiana Harbor Canal	Cooling Water Storm Water
46.	Inland Steel Co.	-008	Indiana Harbor Canal	Cooling Water Storm Water
47.	Inland Steel Co.	-009	Indiana Harbor Canal	Unused Cooling
48.	Inland Steel Co.	-010	Indiana Harbor Canal	Unused Cooling
49.	Inland Steel Co.	-011	Indiana Harbor/ Turning Basin	Cooling Water Storm Water
50.	Inland Steel Co.	-012	Indian Harbor Turning Basin	WWTP Effluent Cooling Water Storm Water

TABLE 2

GCR-LGC-IHC Study

Sampling Sites

SITE NAME (#)	LOCATION	WATER	SEDIMENT
A. Grand Calument River			
1. Lake St. (Gary, IN) (S01) (Sediment S17)	87°16'5"W 41°36'55"N	X	X
2. Kennedy Ave. (S02 & D02)	87°27'40"W 41°36'52"N	X	
3. Indianapolis Blvd. (S03)	87°28'40"W 41°36'53"N	X	
4. Hollman Ave. (S04) (Sediment S16)	87°31'04"W 41°37'27"N	X	X
B. Indiana Habor Canal			
1. 151st St. (S06)	87°28'05"W 41°37'18"N	X	
2. Columbus Drive (S07)	87°28'16"W 41°38'21"N	X	
3. IHB "RR" Bridge (S08) (Sediment S18)	87°28'5"W 41°38'55"N	X	X
4. Mouth of Canal (S09 & D09) (Sediment S19) (Fish S23)	87°27'1"W 41°40'38"N	X	X
5. Turning Basin (S10)	87°26'24"W 41°40'13"N	X	
6. Mouth of Harbor (S11) (Sediment (S20)	87°26'30"W 41°40'47"N	X	X
C. Lake George Canal			
1. Calumet Ave. (S13) (Sediment S21)	87°30'29"W 41°38'47"N	X	X
2. Indianapolis Blvd. (S14 & D14) (Sediment S22 & D22)	87°28'50"W 41°38'48"N	X	X

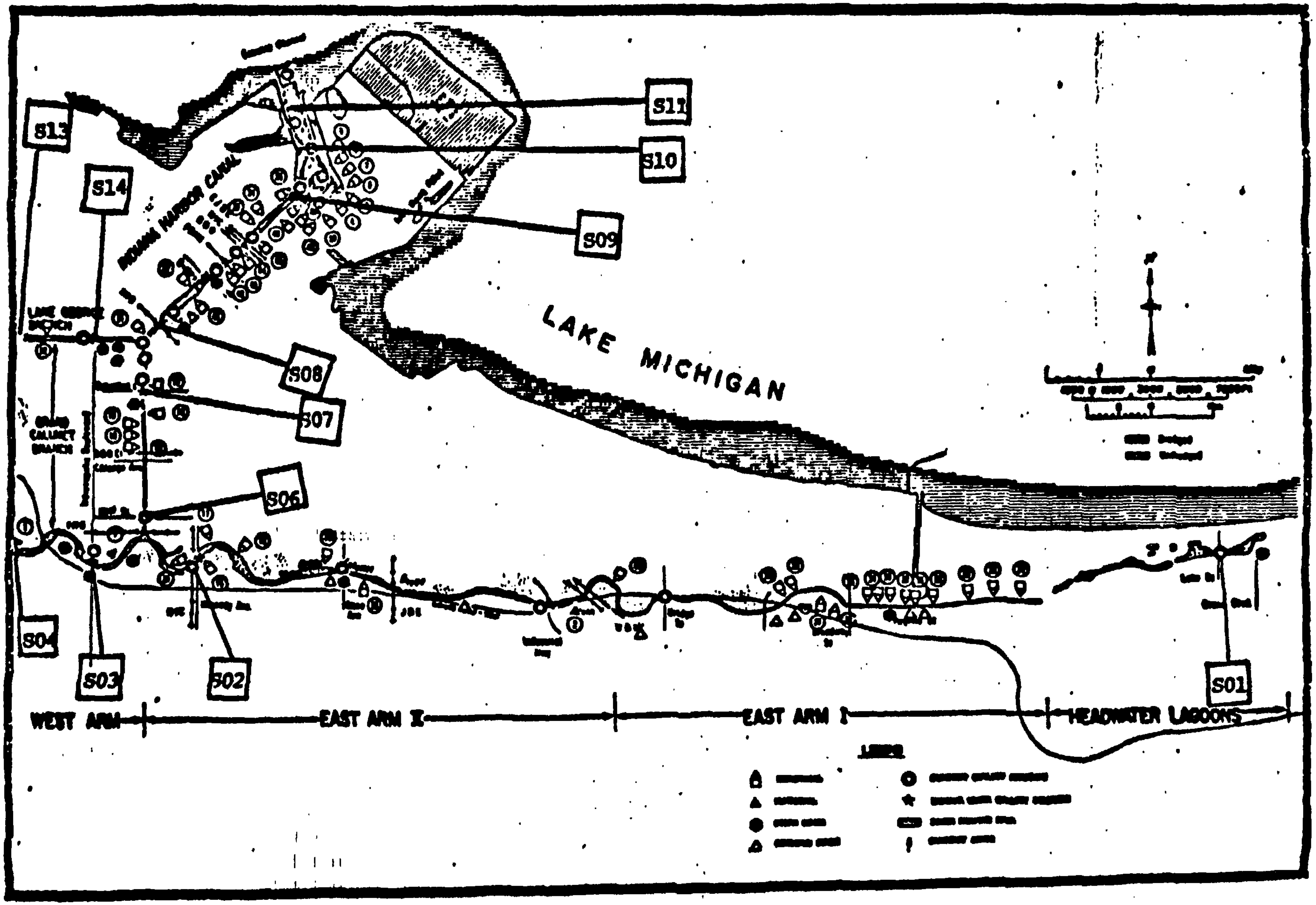

S11
S10
S09
S13
S14
INDIANA HARBOR CANAL
LAKE GEORGE BRANCH
GRAND CALUMET BRANCH
S08
S07
S06
LAKE MICHIGAN
S04
S03
S02
S01
WEST ARM
EAST ARM II
EAST ARM I
HEADWATER LAGOONS
LEGEND

FIGURE 2

53

unavailable for this survey.

Analytical Procedures

EPA approved analytical methods were used for all sample analysis.

Study Results

Data is summarized in Table 3. Comparison of this data with Indiana water quality standards for the Grand Calumet River and the Indiana Harbor Canal (SPC 7R-3, June 25, 1978) would indicate exceedances for the following parameters at the identified sampling sites. (Indiana standards in parenthesis)

GRAND CALUMET RIVER

Indianapolis Blvd	Ammonia-Nitrogen - 3.1 mg/l (1.5 mg/l) Cyanide - 0.234 mg/l (0.1 mg/l) Phenol - 0.014 mg/l (0.01 mg/l) Total Phosphorous - 0.61 mg/l (0.10 mg/l) Chloride - 572 mg/l (125 mg/l) Fluoride - 1.5 mg/l (1.3 mg/l)
Hohman Avenue	Ammonia-Nitrogen - 3.65 mg/l (1.5 mg/l) Total Phosphorous - 3.36 mg/l (0.10 mg/l) Mercury - 0.0019 mg/l (0.0005 mg/l) Oil & Grease - 100 mg/l (10.0 mg/l)

INDIANA HARBOR CANAL

151st Street	Ammonia-Nitrogen - 1.83 mg/l (1.5 mg/l) Cyanide - 0.130 mg/l (0.1 mg/l) Total Phosphorous - 0.11 mg/l (0.10 mg/l)
Columbus Drive	Ammonia-Nitrogen - 2.01 mg/l (1.5 mg/l) Cyanide - .320 mg/l (0.1 mg/l) Total Phosphorous - 0.11 mg/l (0.10 mg/l)

IHB "RR" Bridge	Ammonia-Nitrogen - 1.85 mg/l (1.5 mg/l) Cyanide - 0.128 mg/l (0.1 mg/l) Total Phosphorous - 0.16 mg/l (0.10 mg/l) Oil & Grease - 12 mg/l (10 mg/l)
Mouth of IHC	Cyanide - 0.143 mg/l (0.1 mg/l)
Harbor Mouth	Phenol - 0.011 mg/l (0.01 mg/l)

LAKE GEORGE CANAL

Indianapolis Blvd.	Ammonia-Nitrogen - 1.95 mg/l (1.5 mg/l) Total Phosphorous - 0.18 mg/l (0.10 mg/l)

In addition to these results, high total iron concentrations were observed in water samples at all sites, except Lake Street (GCR) and IHB "RR" Bridge (LGC). The samples ranged from 0.56 mg/l to 2.85 mg/l, with an average of 1.5 mg/l. The Indiana standard for dissolved iron is 0.3 mg/l.

The location of the East Chicago and Hammond wastewater treatment plants in near proximity to the Indianapolis Blvd. and Hohman Avenue sites on the GCR should be noted.

Sediment Data

Sediment data for metals and organics is summarized in Table 3 also. Note that this data is reported as ug/g (ppm).

High metal concentrations were found in nearly all sediment samples. Aluminum concentrations varied from 7.1 ug/g at Hohman Avenue (GCR) to 14,000 ug/g at Indianapolis Blvd. on the CGC. Total iron concentrations varied from 29 ug/g in the GCR to 8800 ug/g in the IHC to 135000 ug/g in the LGC. Cadmium values ranged from 0.3 ug/g in the GCR to 14 in the LGC. Barium values ranging from 0.87 ug/g in the GCR to 160 ug/g in the IHC to 260 ug/g in the LGC were observed. Eighteen different organic compounds were detected at varying concentrations in the sediment samples.

TABLE: 3

NOTE: Values are mg/l unless noted

CENTRAL DISTRICT OFFICE
DATA SUMMARY

SURVEY GCR-LGC-IHC 11/13/80
WATER DATA XXX SEDIMENT DATA

	S01	S02	S03	S04	S06	S07	S08	S09	S10	S11	S13	S14				
Flow																
Water Temp. °C				16	16											
pH (std units) Field				6.8	6.8											
Residual Chlorine																
Alkalinity	121	93	192	216	83	101	104	97	84	84	130	102				
Specific Conductance																
Dissolved Solids	326	225	1615	645	248	279	282	258	169	200	561	295				
Suspended Solids	25	18	70	166	46	11	20	18	29	13	12	18				
Suspended Solids kg/day																
BOD	<3	8	21	53	6	23	10	10	10	10	7	8				
BOD kg/day																
COD	27	21	175	299	28	22	26	45	47	46	61	40				
TOC	7	4	40	95	7	7	7	4	4	4	17	7				
Ammonia-N	0.23	1.00	31.1	3.65	1.83	2.01	1.85	1.37	0.76	0.63	1.41	1.95				
NO2 + NO3 - N	0.20	0.58	0.03	0.03	0.63	0.67	0.87	0.50	0.34	0.33	0.34	0.76				
Kjeldahl Nitrogen	0.86	1.42	43.7	15.8	2.43	3.11	3.14	1.96	1.18	1.04	2.42	3.08				
Cyanide µg/l	5	10	234	13	130	320	128	143	25	12	<5	34				
Phenolics µg/l	9	8	14	8	7	7	9	7	2	11	5	5				
Total Phosphorus	<0.02	0.09	0.61	1.36	0.11	0.11	0.16	0.08	0.07	0.05	0.10	0.18				
Chloride	77	36	572	107	46	51	56	44	29	26	115	61				
Fluoride	0.26	0.27	1.5	0.86	0.42	0.45	0.41	0.32	0.30	0.29	0.52	0.45				
Sulfate	37	41	188	160	49	46	49	46	36	34	153	57				
Oil & Grease	7	7	8	100	<5	<5	12	9	<5	5	<5	<5				
Fecal Coliform																
Total Dissolved Oxygen																

57

60

TABLE 3, cont'd

[illegible] DISTRICT [illegible]
DATA SUMMARY

WATER DATA XXX SEDIMENT DATA ____

		S01	S02	S03	S04	S06	S07	S08	S09	S10	S11	S13	S14
Total Aluminum	ug/l	<90	<90	934	1190	<90	<90	<90	<90	<90	<90	<90	<90
" Arsenic	"	3.1	<2	14	<2	17	18	20	18	19	17	<2	<2
" Barium	"	41	19	39	79	19	21	23	21	20	21	50	24
" Boron	"												
" Cadmium	"	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
" Chromium	"	<5	<5	8	34	<5	9	14	6	8	<5	7	20
" Chromium hex	"												
" Cobalt	"	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
" Copper	"	<6	<6	19	48	<6	15	7	9	<6	<6	<6	11
" Iron	"	230	801	1800	2850	1030	1480	1690	1120	2190	560	209	1630
" Lead	"	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	32
" Manganese	"	27	57	150	203	30	65	73	57	57	31	195	77
" Mercury	"	0.1	0.1	0.3	1.9	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.3
" Nickel	"	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
" Selenium	"	<2	<2	15	<2	<2	<2	<2	<2	<2	<2	<2	<2
" Silver	"	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
" Tin	"												
" Vanadium	"	<5	<5	<5	7	<5	<5	<5	<5	<5	<5	<5	7
" Zinc	"	<50	65	78	99	71	76	100	85	70	<50	<50	109
" Antimony	"						<2	<2	<2	<2	<2	<2	<2
" Thallium	"	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
" Beryllium	"	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
" Calcium	mg/l	49.5	43	224	120	48.5	51.6	51.5	46	40.1	39.8	58.4	52.3
" Magnesium	"	15.1	12	19.1	20.1	12.6	12.3	12.3	11.6	11.1	10.8	18.4	12.5
Total Sodium	mg/l	45.1	20.2	182	96.1	24.4	27.4	34.3	21.6	13.6	14.2	88.0	33.9
" Molybdenum	ug/l	<10	<10	<10	<10	<10	12	<10	<10	<10	<10	25	<10
" Titanium	"	<6	<6	10	28	<6	9	<6	7	7	10	7	12

TABLE 3, cont'd

CENTRAL DISTRICT OFFICE
DATA SUMMARY

SURVEY GCR-LGC-IMC 11/13/80
WATER DATA XXX SEDIMENT DATA ______

	S01	S02	S03	S04	S06	S07	S08	S09	S10	S11	S13	S14
Chlorophyll(a) µg/l	2.79	1.42	1.03	0.29	2.10	2.31	1.47	1.57	2.33	1.17	0.83	1.47
Pheophyton(a) µg/l	2.39	1.35	2.05	0.78	1.98	2.13	1.68	1.30	2.48	0.93	0.88	2.42
PCB 1242 µg/l	1.8.											

TABLE 3, cont'd

NOTE: Values are reported as µg/g

CENTRAL DISTRICT OFFICE
DATA SUMMARY

SURVEY GCR-LGC-IHC 11/13/80
WATER DATA ______ SEDIMENT DATA XXXX

		S01	S04	S08	S09	S11	S13	S14			FISH-S09						
Total Aluminum	µg/g	10	7.1	7700	6900	10000	7700	14000			11						
" Arsenic	"	28	10	29	38	70	29	76			0.34						
" Barium	"	87	83	160	120	52	160	260									
" Boron	"										4						
" Cadmium	"	9	0.3	2	7	4	6	14			<0.10						
" Chromium	"	390	170	400	530	200	130	1200			0.44						
" Chromium [illegible]	"																
" Cobalt	"	<1	<1	8	23	11	5	17			<0.3						
" Copper	"	800	47	400	210	79	430	440			1.4						
" Iron	"	58	29	8800	16600	75000	5700	135000			29						
" Lead	"	1600	63	470	790	230	1000	2000			<3.5						
" Manganese	"	500	4800	860	2100	650	840	1700			0.81						
" Mercury	"																
" Nickel	"	99	31	160	89	44	54	160			<0.75						
" Selenium	"	<2	<2	<2	<2	<2	<2	<2									
" Silver	"	22	2	5	8	2	2	12									
" Tin	"																
" Vanadium	"	55	55	45	71	46	120	130			<0.25						
" Zinc	"	2700	62	2000	3900	1700	1200	5700			50						
" Antimony	"			<2	<2	<2	<2	<2									
" Thallium	"	2.8	<2	2	7	3.3	2.4	7.7									
" Beryllium	"	1	2	1	2	1	2	2									
" Calcium	mg/mg	43.3	57.1	57.5	36.3	42	42.8	46.7			4.9						
" Magnesium	"	10.9	13.5	14.2	9.1	14.5	10.9	12			0.31						
Total Sodium		0.3	1.6	2.5	<.1	.2	.8	<.1			0.95						
" Molybdenum	ug/g	34	22	56	56	37	52	66			<0.5						
" Titanium	ug/g	200	320	180	210	110	280	250			<0.25						

60

TABLE 3, cont'd

NOTE: Values are reported as µg/g

CENTRAL DISTRICT OFFICE
DATA SUMMARY

SURVEY CCR-ICC-IIC 11/13/8?
WATER DATA ____ SEDIMENT DATA XXXXX

	S01 ✓	S04 ✓	S08 ✓	S09 ✓	S11 ✓	S13 ✓	S14 ✓			S09 Fish
Fluoranthene µg/g		[illegible]	20	18	2.6	5.2	6.4			
Bis(2 ethyl)hexyl Phthalate µg/g	5.6		0.44	3.2	.8	.83	.64			6.2
Benzo(a)Anthracene µg/g	0.57	0.37	10	14	1.6	5.0	1.3			
Benzo(a)Pyrene µg/g		0.48	5.7	8.7		4.4	6.5			
3-4 Benzofluoranthene µg/g		0.54	6.4	8.8	2.6	2.3	6.4			
Benzo(k)Fluoranthene µg/g		0.54	6.4	8.8	3.6	39 4.3	6.4			
Anthracene µg/g	1.1	0.44	47	18	3.4	4.4	15.4			
Phenanthrene µg/g	1.1	0.44	47	18	3.4	18	15.4			
Pyrene µg/g	1.1	0.48		18		4.2	2.2			
Chrysene µg/g	0.57		10	14	1.6		6.3			
PCB 1248 µg/g			0.98	0.72	[illegible]		1.4			
PCB 1242 µg/g		0.20								
Napthalene µg/g			6.8		1.3					
Acenaphthylene µg/g			1.5							
Benzo(GHI)Perylene µg/g			3.0	2.0		.4				
Fluorene µg/g			5.3	2.0						
Indeno(1,2,3,c d) Pyrene µg/g			1.8	2.4		.71				
Dibenzo(a,h)Anthracene µg/g				1.3						
Acenaphthene µg/g										.07

61

ATTACHMENT TO TABLE 3

FINAL REPORT

MS DATA FILE FRN: 9102

NAME: CDO-1269; 81-CCA3S23 VOL 0.5ML FISH
MISC DATA: 10-16-81 BTL#3 Q9102 D9102

IDFILE FRN: 4670

IDFILE NAME: ACID ANALYSIS
MISC DATA: D-10 P INSTD

	NAME	CONCENTRATION (PPM)
STANDARD	D-10 PHENANTHRENE	4.2
1	2-NITROPHENOL	LESS THAN 1.1
2	2-CHLOROPHENOL	LESS THAN 0.5
3	PHENOL	LESS THAN 0.5
4	2,4-DIMETHYLPHENOL	LESS THAN 0.6
5	2,4-DICHLOROPHENOL	LESS THAN 0.6
6	P-T-BUTYLPHENOL	LESS THAN 0.3
7	P-CHLORO-M-CRESOL	LESS THAN 2.0
8	2,4,6-TRICHLOROPHENOL	LESS THAN 1.3
9	PENTACHLOROPHENOL	LESS THAN 7.3
10	4-NITROPHENOL	LESS THAN 19.7
11	4,6-DINITRO-ORTHO CRESOL	LESS THAN 4.4

ATTACHMENT TO TABLE 3

VOLATILE ANALYSIS
FINAL REPORT

MS DATA FILE FRN: 8112

NAME: CDO-1269 FISH 10GM IN 20 ML INSTD: 25 PPB
MISC DATA: NO VE 30-160 6M 8C/MIN 30M F.HOLD SIMAQ YF & LS

PRIORITY POLLUTANTS:			CONCENTRATION (MG/KG)
1	TRICHLOROMETHANE		.02
2	1,1,1-TRICHLOROETHANE		.02
3	BENZENE		.03
4	METHYL BENZENE		.07
OTHER VOLATILE ORGANIC COMPOUNDS:*			
5	ETHANOL	(.05)	.04
6	PROPANAL	(.05)	1.15
7	2-METHYL-2-PROPANAMINE	(.05)	1.16
8	1-METHOXY-1-PROPENE	(.05)	.03
9	BUTANAL	(.05)	.30
10	2-METHYL-2-PROPEN-1-OL	(.05)	.13
11	ACETICACID ETHYLESTER	(.05)	.07
12	PENTADIENES	(.05)	.12
13	UNKNOWN	(.05)	.08
14	CYCLOPENTANOL	(.10)	.20
15	HEXANE	(.10)	.16
16	2-METHYL-2-BUTANAL	(.10)	.08
17	HEXANAL	(.10)	.47
18	4-METHYL HEXANAL	(.10)	.29

* CONCENTRATIONS ARE ESTIMATED BASED UPON THE RESPONSE OF INTERNAL STANDARD (2-BROMO-1-CHLORO-PROPANE); ESTIMATED RELATIVE RESPONSE RATIOS ARE SHOWN IN THE PARENTHESIS.

ATTACHMENT TO TABLE 3

ORGANIC SCAN: DATA SET CDO-1269, FISH SAMPLE COLLECTED IN THE VICINITY OF THE INDIANA HARBOR

CRL SAMPLE NUMBER 81-CC03S23

(UNITS ARE MG/KG)

OMPOUND	ESTIMATED CONCENTRATION
ETHYL NAPHTHALENE (1 ISOMER)	2.3
ECAHYDRO-1,6-DIMETHYL NAPHTHALENE	2.6
-METHYLTETRADECANOIC ACID, METHYL ESTER	2
-OCTADECANOIC ACID(Z)/9,12-OCTADECADIENOIC ACID (Z,Z)	210
-OCTADECADIENOIC ACID (Z) ETHYL ESTER	87
-[illegible]ADECENOIC ACID (Z) ETHYL ESTER	120
, 8,11,14-EICOSATETRAENOIC ACID, ETHYL ESTER	6.1
NIDENTIFIED COMPOUND (SPECTRUM 359)	3.5
NIDENTIFIED COMPOUND (SPECTRUM 1532)	9.6
NIDENTIFIED COMPOUND (SPECTRUM 1554)	3.8

Analytical Results for Data Set CDO-1253 (Grand Calumet)

(Purgeable Fraction)

Compound	Sample No. (81-CC03xxx) and Concentration (PPB)								
	R05	S01	S02	S03	D03	S04	S06	S16†	S17†
1,1,1-trichloroethane	1	0.34	K 1	0.74	0.78	0.57	0.43	K 1	K 1
1,1-dichloroethane	K 1	K 1	K 1	0.15	0.27	0.34	K 1	K 1	K 1
1,2-dichloroethene	K 1	K 1	K 1	0.20	0.29	K 1	K 1	K 1	K 1
Chloroform	K 1	K 1	K 1	5.9	6.7	0.78	0.21	K 1	K 1
1,2-dichloroethane	K 1	K 1	K 1	120	360	1600	4.8	K 1	K 1
Trichloroethene	K 1	K 1	K 1	1.4	1.0	0.50	K 1	K 1	K 1
Benzene	K 1	K 1	K 1	0.57	0.13	K 1	K 1	K 1	K 1
Tetrachloroethene	K 1	K 1	K 1	3.3	2.5	0.70	0.076	K 1	K 1
Bromodochloromethane	K 1	K 1	K 1	1.5	1.0	K 1	K 1	K 1	K 1
Dibromochloromethane	K 1	K 1	K 1	K 1	0.20	K 1	K 1	K 1	K 1

†Sediment